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ENCYCLOPÆDIA BRITANNICA.

SCRIPTURE continued from laſt Volume.

55
Jeremiah.

JEREMIAH was called to the prophetic office in the 13th year of the reign of Joſiah the ſon of Amon, A. M. 3376, A. C. 628, and continued to prophecy upwards of 40 years, during the reigns of the degenerate princes of Judah, to whom he boldly threatened thoſe marks of the divine vengeance which their rebellious conduct drew on themſelves and their country. After the deſtruction of Jeruſalem by the Chaldeans, he was ſuffered by Nebuchadnezzar to remain in the deſolate land of Judea to lament the calamities of his infatuated countrymen. He was afterwards, as he himſelf informs us, carried with his diſciple Baruch into Egypt, by Johanan the ſon of Kareah.

It appears from ſeveral paſſages that Jeremiah committed his prophecies to writing. In the 36th chapter we are informed, that the prophet was commanded to write upon a roll all the prophecies which he had uttered; and when the roll was deſtroyed by Jehoiakim the king, Jeremiah dictated the ſame prophecies to Baruch, who wrote them together with many additional circumſtances. The works of Jeremiah extend to the laſt verſe of the 51ſt chapter; in which we have theſe words, "Thus far the words of Jeremiah." The 52d chapter was therefore added by ſome other writer. It is, however, a very important ſupplement, as it illuſtrates the accompliſhment of Jeremiah's prophecies reſpecting the fate of Zedekiah.

56
Chronological arrangement of his writings.

The prophecies of Jeremiah are not arranged in the chronological order in which they were delivered. What has occaſioned this tranſpoſition cannot now be determined. It is generally maintained, that if we conſult their dates, they ought to be thus placed:

In the reign of Joſiah the firſt 12 chapters.

In the reign of Jehoiakim, chapters xiii. xx. xxi. v. 11, 14.; xxii. xxiii. xxv. xxvi. xxxv. xxxvi. xlv.—xlix. 1—33.

In the reign of Zedekiah, chap. xxi. 1—10. xxiv. xxvii. xxxiv. xxxvii. xxxix. xlix. 34—39. l. and li.

Under the government of Gedaliah, chapters xl. xliv. The prophecies which related to the Gentiles were contained in the 46th and five following chapters, being placed at the end, as in ſome meaſure unconnected with the reſt. But in ſome copies of the Septuagint theſe ſix chapters follow immediately after the 13th verſe of the 25th chapter.

Jeremiah, though deficient neither in elegance nor ſublimity, muſt give place in both to Iſaiah. Jerome ſeems to object againſt him a ſort of ruſticity of language, no veſtige of which Dr Lowth was able to diſcover. His ſentiments, it is true, are not always the moſt elevated, nor are his periods always neat and compact; but theſe are faults common to thoſe writers whoſe principal aim is to excite the gentler affections, and to call forth the tear of ſympathy or ſorrow. This obſervation is very ſtrongly exemplified in the Lamentations, where theſe are the prevailing paſſions; it is, however, frequently inſtanced in the prophecies of this author, and moſt of all in the beginning of the book (L), which is chiefly poetical. The middle of it is almoſt entirely hiſtorical. The latter part, again, conſiſting of the laſt ſix chapters, is altogether poetical (M); it contains ſeveral different predictions, which are diſtinctly marked; and in theſe the prophet approaches very near the ſublimity of Iſaiah. On the whole, however, not above half the book of Jeremiah is poetical.

The book of Lamentations, as we are informed in the title, was compoſed by Jeremiah. We ſhall preſent to our reader an account of this elegiac poem from the elegant pen of Dr Lowth. 57
The book of Lamentations.

The Lamentations of Jeremiah (for the title is properly and ſignificantly plural) conſiſt of a number of plaintive effuſions, compoſed on the plan of the funeral dirges, all on the ſame ſubject, and uttered without connection as they roſe in the mind, in a long courſe of ſeparate ſtanzas. Theſe have afterwards been put together, and formed into a collection or correſpondent whole. If any reader, however, ſhould expect to find in them an artificial and methodical arrangement of the general ſubject, a regular diſpoſition of the parts, a perfect connection and orderly ſucceſſion in the matter, and

(L) See the whole of chap. ix. chap. xiv. 17, &c. xx. 14—18.

(M) Chap. xlvi.—li. to ver. 50. Chap. lii. properly belongs to the Lamentations, to which it ſerves as an exordium.

Scripture. and with all this an uninterrupted ſeries of elegance and correctneſs, he will really expect what was foreign to the prophet's deſign. In the character of a mourner, he celebrates in plaintive ſtrains the obſequies of his ruined country: whatever preſented itſelf to his mind in the midſt of deſolation and miſery, whatever ſtruck him as particularly wretched and calamitous, whatever the inſtant ſentiment of ſorrow dictated, he pours forth in a kind of ſpontaneous effuſion. He frequently pauſes, and, as it were, ruminates upon the ſame object; frequently varies and illuſtrates the ſame thought with different imagery, and a different choice of language; ſo that the whole bears rather the appearance of an accumulation of correſponding ſentiments, than an accurate and connected ſeries of different ideas, arranged in the form of a regular treatiſe. There is, however, no wild incoherency in the poem; the tranſitions are eaſy and elegant.

58 How divided. The work is divided into five parts: in the firſt, ſecond, and fourth chapters, the prophet addreſſes the people in his own perſon, or introduces Jeruſalem as ſpeaking. In the third chapter a chorus of the Jews is repreſented. In the fifth the whole captive Jews pour forth their united complaints to Almighty God. Each of theſe five parts is diſtributed into 22 ſtanzas, according to the number of the letters of the alphabet. In the firſt three chapters theſe ſtanzas conſiſt of three lines. In the firſt four chapters the initial letter of each period follows the order of the alphabet; and in the third chapter each verſe of the ſame ſtanza begins with the ſame letter. In the fourth chapter all the ſtanzas are evidently diſtichs, as alſo in the fifth, which is not acroſtic. The intention of the acroſtic was to aſſiſt the memory to retain ſentences not much connected. It deſerves to be remarked, that the verſes of the firſt four chapters are longer by almoſt one half than Hebrew verſes generally are: The length of them ſeems to be on an average about 12 ſyllables. The prophet appears to have choſen this meaſure as being ſolemn and melancholy.

Lowth. 59 The ſubject and beauty of it. "That the ſubject of the Lamentations is the deſtruction of the holy city and temple, the overthrow of the ſtate, the extermination of the people; and that theſe events are deſcribed as actually accompliſhed, and not in the ſtyle of prediction merely, muſt be evident to every reader; though ſome authors of conſiderable reputation * have imagined this poem to have been compoſed on the death of King Joſiah. The prophet, indeed, has ſo copiouſly, ſo tenderly, and poetically, bewailed the misfortunes of his country, that he ſeems completely to have fulfilled the office and duty of a mourner. In my opinion, there is not extant any poem which diſplays ſuch a happy and ſplendid ſelection of imagery in ſo concentrated a ſtate. What can be more elegant and poetical, than the deſcription of that once flouriſhing city, lately chief among the nations, ſitting in the character of a female, ſolitary, afflicted, in a ſtate of widowhood, deſerted by her friends, betrayed by her deareſt connections, imploring relief, and ſeeking conſolation in vain? What a beautiful perſonification is that of "the ways of Sion mourning becauſe none are come to her ſolemn feaſts?" How tender and pathetic are the following complaints?

* Joſephus, Jerome, Uſſerius, &c

Chap. i. 12, 16.

Is this nothing to all you who paſs along the way? behold and ſee,
If there be any ſorrow, like unto my ſorrow, which is inflicted on me;
Which Jehovah inflicted on me in the day of the violence of his wrath.
For theſe things I weep, my eyes ſtream with water;
Becauſe the comforter is far away, that ſhould tranquilize my ſoul:
My children are deſolate, becauſe the enemy was ſtrong.

But to detail its beauties would be to tranſcribe the entire poem." 60

Ezekiel. Ezekiel was carried to Babylon as a captive, and received the firſt revelations from heaven, in the fifth year of Jehoiakim's captivity, A. C. 595. The book of Ezekiel is ſometimes diſtributed under different heads. In the three firſt chapters the commiſſion of the prophet is deſcribed. From the fourth to the thirty-ſecond chapter incluſive, the calamities that befel the enemies of the Jews are predicted, viz. the Ammonites, the Moabites, and Philiſtines. The ruin of Tyre and of Sidon, and the fall of Egypt, are particularly foretold; prophecies which have been fulfilled in the moſt literal and aſtoniſhing manner, as we have been often aſſured by the relation of hiſtorians and travellers. From the 32d chapter to the 40th he inveighs againſt the hypocriſy and murmuring ſpirit of his countrymen, admoniſhing them to reſignation by promiſes of deliverance. In the 38th and 39th chapters he undoubtedly predicts the final return of the Jews from their diſperſion in the latter days, but in a language ſo obſcure that it cannot be underſtood till the event take place. The nine laſt chapters of this book furniſh the deſcription of a very remarkable viſion of a new temple and city, of a new religion and polity. 61

Character as a writer. "Ezekiel is much inferior to Jeremiah in elegance; in ſublimity he is not even excelled by Iſaiah: but his ſublimity is of a totally different kind. He is deep, vehement, tragical; the only ſenſation he affects to excite is the terrible; his ſentiments are elevated, fervid, full of fire, indignant; his imagery is crouded, magnificent, terrific, ſometimes almoſt to diſguſt: his language is pompous, ſolemn, auſtere, rough, and at times unpoliſhed: he employs frequent repetitions, not for the ſake of grace or elegance, but from the vehemence of paſſion and indignation. Whatever ſubject he treats of, that he ſeduloully purſues, from that he rarely departs, but cleaves as it were to it; whence the connection is in general evident and well preſerved. In many reſpects he is perhaps excelled by the other prophets; but in that ſpecies of compoſition to which he ſeems by nature adapted, the forcible, the impetuous, the great and ſolemn, not one of the ſacred writers is ſuperior to him. His diction is ſufficiently perſpicuous; all his obſcurity conſiſts in the nature of the ſubject. Viſions (as for inſtance, among others, thoſe of Hoſea, Amos, and Jeremiah) are neceſſarily dark and confuſed. The greater part of Ezekiel, towards the middle of the book eſpecially, is poetical, whether we regard the matter or the diction. His periods, however, are frequently ſo rude and incompact, that I am often at a loſs how to pronounce concerning his performance in this reſpect. Lowth.

"Iſaiah, Jeremiah, and Ezekiel, as far as relates to ſtyle, may be ſaid to hold the ſame rank among the Hebrews, as Homer, Simonides, and Æſchylus among the Greeks."

So

Scripture.

62 Daniel.

So full an account of Daniel and his writings has been already given under the article DANIEL, that little remains to be ſaid on that ſubject. Daniel flouriſhed during the ſucceſſive reigns of ſeveral Babyloniſh and Median kings to the conqueſt of Babylon by Cyrus. The events recorded in the 6th chapter were contemporary with Darius the Mede; but in the 7th and 8th chapters Daniel returns to an earlier period, to relate the viſions which he beheld in the three firſt years of Belſhazzar's reign; and thoſe which follow in the four laſt chapters were revealed to him in the reign of Darius. The laſt ſix chapters are compoſed of prophecies delivered at different times; all of which are in ſome degree connected as parts of one great ſcheme. They extend through many ages, and furniſh the moſt ſtriking deſcription of the fall of ſucceſſive kingdoms, which were to be introductory to the eſtabliſhment of the Meſſiah's reign. They characterize in deſcriptive terms the four great monarchies of the world to be ſucceeded by "that kingdom which ſhould not be deſtroyed."

63 Character of his prophecies.

The whole book of Daniel being no more than a plain relation of facts, partly paſt and partly future, muſt be excluded the claſs of poetical prophecy. Much indeed of the parabolic imagery is introduced in that book; but the author introduces it as a prophet only; as viſionary and allegorical ſymbols of objects and events, totally untinctured with the true poetical colouring. The Jews, indeed, would refuſe to Daniel even the character of a prophet: but the arguments under which they ſhelter this opinion are very futile; for thoſe points which they maintain concerning the conditions on which the gift of prophecy is imparted, the different gradations, and the diſcrimination between the true prophecy and mere inſpiration, are all trifling and abſurd, without any foundation in the nature of things, and totally deſtitute of ſcriptural authority. They add, that Daniel was neither originally educated in the prophetic diſcipline and precepts, nor afterwards lived conformably to the manner of the prophets. It is not, however, eaſy to comprehend how this can diminiſh his claim to a divine miſſion and inſpiration; it may poſſibly enable us, indeed, to aſſign a reaſon for the diſſimilarity between the ſtyle of Daniel and that of the other prophets, and for its poſſeſſing ſo little of the diction and character of poetry, which the reſt ſeem to have imbibed in common from the ſchools and diſcipline in which they were educated.

64 Their authenticity.

The prophecies of Daniel appear ſo plain and intelligible after their accompliſhment, that Porphyry, who wrote in the 3d century, affirms, that they were written after the events to which they refer took place. A little reflection will ſhow the abſurdity of this ſuppoſition. Some of the prophecies of Daniel clearly refer to Antiochus Epiphanes, with whoſe oppreſſions the Jews were too well acquainted. Had the book of Daniel not made its appearance till after the death of Epiphanes, every Jew who read it muſt have diſcovered the forgery. And what motive could induce them to receive it among their ſacred books? It is impoſſible to conceive *one*. Their character was quite the reverſe: their reſpect for the Scripture had degenerated into ſuperſtition. But we are not left to determine this important point from the character of the Jews; we have acceſs to more deciſive evidence; we are ſure that the book of Daniel contains prophecies, for ſome of them have been accompliſhed ſince the time of Porphyry; particularly thoſe reſpecting Antichriſt: now, if it contains any prophecies, who will take upon him to affirm that the divine Spirit, which dictated theſe many centuries before they were fulfilled, could not alſo have delivered prophecies concerning Antiochus Epiphanes?

The language in which the book of Daniel is compoſed proves that it was written about the time of the Babyloniſh captivity. Part of it is pure Hebrew: a language in which none of the Jewiſh books were compoſed after the age of Epiphanes. Theſe are arguments to a deiſt. To a Chriſtian the internal marks of the book itſelf will ſhow the time in which it was written, and the teſtimony of Ezekiel will prove Daniel to be at leaſt his contemporary *.

* Ezek. xiv. 14. xxviii. 3.

65 Twelve minor prophets.

The twelve minor prophets were ſo called, not from any ſuppoſed inferiority in their writings, but on account of the ſmall ſize of their works. Perhaps it was for this reaſon that the Jews joined them together, and conſidered them as one volume. Theſe 12 prophets preſented in ſcattered hints a lively ſketch of many particulars relative to the hiſtory of Judah and of Iſrael, as well as of other kingdoms; they propheſy with hiſtorical exactneſs the fate of Babylon, of Nineveh, of Tyre, of Sidon, and of Damaſcus. The three laſt prophets eſpecially illuſtrate many circumſtances at a period when the hiſtorical pages of Scripture are cloſed, and when profane writers are entirely wanting. At firſt the Jewiſh prophets appeared only as ſingle lights, and followed each other in individual ſucceſſion; but they became more numerous about the time of the captivity. The light of inſpiration was collected into one blaze, previous to its ſuſpenſion; and it ſerved to keep alive the expectations of the Jews during the awful interval which prevailed between the expiration of prophecy and its grand completion on the advent of Chriſt.

Gray's Key to the Old Teſtament.

66 Prophecies of Hoſea.

Hoſea has been ſuppoſed the moſt ancient of the 12 minor prophets. He flouriſhed in the reign of Jeroboam II. king of Iſrael, and during the ſucceſſive reigns of Uzziah, Jotham, Ahaz, and Hezekiah, kings of Judah. He was therefore nearly contemporary with Iſaiah, Amos, and Jonah. The prophecies of Hoſea being ſcattered through the book without date or connection, cannot with any certainty be chronologically arranged.

67 Character of their ſtyle.

Hoſea is the firſt in order of the minor prophets, and is perhaps, Jonah excepted, the moſt ancient of them all. His ſtyle exhibits the appearance of very remote antiquity; it is pointed, energetic, and conciſe. It bears a diſtinguiſhed mark of poetical compoſition, in that priſtine brevity and condenſation which is obſervable in the ſentences, and which later writers have in ſome meaſure neglected. This peculiarity has not eſcaped the obſervation of Jerome: "He is altogether (ſays he, ſpeaking of this prophet) laconic and ſententious." But this very circumſtance, which anciently was ſuppoſed no doubt to impart uncommon force and elegance, in the preſent ruinous ſtate of the Hebrew literature is productive of ſo much obſcurity, that although the general ſubject of this writer be ſufficiently obvious, he is the moſt difficult and perplexed of all the prophets. There is, however, another reaſon for the obſcurity of his ſtyle: Hoſea propheſied during the reigns of the four kings of Judah, Uzziah, Jotham, Ahaz, and Hezekiah. The duration of his miniſtry, therefore, in whatever

Scripture ever manner we calculate, muft include a very confiderable fpace of time. We have now only a fmall volume of his remaining, which feems to contain his principal prophecies; and thefe are extant in a continued feries, with no marks of diftinction as to the times in which they were publifhed, or the fubjects of which they treat. There is, therefore, no caufe to wonder if, in perufing the prophecies of Hofea, we fometimes find ourfelves in a fimilar predicament with thofe who confulted the fcattered leaves of the Sibyl.

As a fpecimen of Hofea's ftyle, we felect the following beautiful pathetic paffage:

How fhall I refign thee, O Ephraim!
How fhall I deliver thee up, O Ifrael!
How fhall I refign thee as Admah!
How fhall I make thee as Zeboim!
My heart is changed within me;
I am warmed alfo with repentance towards thee.
I will not do according to the fervour of my wrath;
I will not return to deftroy Ephraim:
For I am God, and not man;
Holy in the midft of thee, though I inhabit not thy cities.

68 Prophecies of Joel.

Concerning the date of the prophecy of Joel there are various conjectures. The book itfelf affords nothing by which we can difcover when the author lived, or upon what occafion it was written. Joel fpeaks of a great famine, and of mifchiefs that happened in confequence of an inundation of locufts; but nothing can be gathered from fuch general obfervations to enable us to fix the period of his prophecy. St Jerome thinks (and it is the general opinion) that Jael was contemporary with Hofea. This is poffibly true; but the foundation on which the opinion refts is very precarious, viz. That when there is no proof of the time in which a prophet lived, we are to be guided in our conjectures refpecting it by that of the preceding prophet whofe epoch is better known. As this rule is not infallible, it therefore ought not to hinder us from adopting any other opinion that comes recommended by good reafons. Father Calmet places him under the reign of Jofiah, at the fame time with Jeremiah, and thinks it probable that the famine to which Joel alludes, is the fame with that which Jeremiah predicted, ch. viii. 13.

69 Character of their ftyle.

The ftyle of Joel is effentially different from that of Hofea; but the general character of his diction, though of a different kind, is not lefs poetical. He is elegant, perfpicuous, copious, and fluent; he is alfo fublime, animated, and energetic. In the firft and fecond chapters he difplays the full force of the prophetic poetry, and fhows how naturally it inclines to the ufe of metaphors allegories, and comparifons. Nor is the connection of the matter lefs clear and evident than the complexion of the ftyle: this is exemplified in the difplay of the impending evils which gave rife to the prophecy, the exhortation to repentance; the promifes of happinefs and fuccefs both terreftrial and eternal to thofe who become truly penitent; the reftoration of the Ifraelites; and the vengeance to be taken of their adverfaries. But while we allow this juft commendation to his perfpicuity both in language and arrangement, we muft not deny that there is fometimes great obfcurity obfervable in his fubject, and particularly in the latter part of the prophecy.

Lowth on Hebrew Poetry, Sect. 21.

The following prophecy of a plague of locufts is defcribed with great fublimity of expreffion:

For a nation hath gone up on my land,
Who are ftrong, and without number:
They have deftroyed my vine, and have made my fig-tree a broken branch.
They have made it quite bare, and caft it away: the branches thereof are made white.
The field is laid wafte; the ground mourneth *.

* Joel i. 6. 7, 10, &c.

70 Prophecies of Amos.

Amos was contemporary with Hofea. They both began to prophecy during the reigns of Uzziah over Judah, and of Jeroboam II. over Ifrael. Amos faw his firft vifion two years before the earthquake, which Zechariah informs us happened in the days of Uzziah. See Amos.

Amos was a herdfman of Tekoa, a fmall town in the territory of Judah, and a gatherer of fycamore fruit. In the fimplicity of former times, and in the happy climates of the Eaft, thefe were not confidered as difhonourable occupations. He was no prophet (as he informed Amaziah †), neither was he a prophet's fon, that is, he had no regular education in the fchools of the prophets.

† Amos vii. 14.

The prophecies of Amos confift of feveral diftinct difcourfes, which chiefly refpect the kingdom of Ifrael; yet fometimes the prophet inveighs againft Judah, and threatens the adjacent nations, the Syrians, Philiftines, Tyrians, Edomites, Ammonites, and Moabites.

71 Their ftyle.

Jerome calls Amos "rude in fpeech, but not in knowledge ‡;" applying to him what St Paul modeftly profeffes of himfelf §. "Many (fays Dr Lowth) have followed the authority of Jerome in fpeaking of this prophet, as if he were indeed quite rude, ineloquent, and deftitute of all the embellifhments of compofition. The matter is, however, far otherwife. Let any perfon who has candour and perfpicacity enough to judge, not from the man but from his writings, open the volume of his predictions, and he will, I think, agree with me, that our fhepherd 'is not a whit behind the very chief of the prophets ||.' He will agree, that as in fublimity and magnificence he is almoft equal to the greateft, fo in fplendour of diction and elegance of expreffion he is fcarcely inferior to any. The fame celeftial Spirit indeed actuated Ifaiah and Daniel in the court and Amos in the fheep-folds; conftantly felecting fuch interpreters of the divine will as were beft adapted to the occafion, and fometimes 'from the mouth of babes and fucklings perfecting praife:' occafionally employing the natural eloquence of fome, and occafionally making others eloquent."

‡ *Proem. Comment. in Amos.*
§ 2 Cor. xi. 6.
|| 2 Cor. xi.

Mr Locke has obferved, that the comparifons of this prophet are chiefly drawn from lions and other animals with which he was moft accuftomed; but the fineft images and allufions are drawn from fcenes of nature. There are many beautiful paffages in the writings of Amos, of which we fhall prefent one fpecimen:

Wo to them that are at eafe in Zion,
And truft in the mountains of Samaria;
Who are named chief of the nations,
To whom the houfe of Ifrael came:
Pafs ye unto Calneh and fee,
And from thence go to Hamath the Great;

Then

Scripture.

Then go down to Gath of the Philiftines;
Are they better than thefe kingdoms?
Or their borders greater than their borders?
Ye that put far away the evil day,
And caufe the feat of violence to come near;
That lie upon beds of ivory,
And ftretch yourfelves upon couches;
That eat the lambs out of the flock,
And the calves out of the midft of the ftall;
That chant to the found of the viol,
And like David devife inftruments of mufic;
That drink wine in bowls,
|| Ch. vi. 1.—6. And anoint yourfelves with chief ointments;
But are not grieved for the affliction of Jofeph ||.

72
Of Obadiah. The writings of Obadiah, which confift of one chapter, are compofed with much beauty, and unfold a very interefting fcene of prophecy. Of this prophet little can be faid, as the fpecimen of his genius is fo fhort, and the greater part of it included in one of the prophecies of Jeremiah. Compare Ob. 1—9. with Jer. xlix. 14, 15, 16. See OBADIAH.

73
Of Jonah. Though Jonah be placed the fixth in the order of the minor prophets both in the Hebrew and Septuagint, he is generally confidered as the moft ancient of all the prophets, not excepting Hofea. He lived in the kingdom of Ifrael, and prophefied to the ten tribes under the reign of Joafh and Jeroboam. The book of Jonah is chiefly hiftorical, and contains nothing of poetry but the prayer of the prophet. The facred writers, and our Lord himfelf, fpeak of Jonah as a prophet of confiderable eminence *. See JONAH.

* 2 Kings xiv. 25. Matth. xii. 39. 41. xvi. 4. Luke xi. 29.

74
Of Micah. Micah began to prophefy foon after Ifaiah, Hofea, Joel, and Amos; and he prophefied between A. M. 3246, when Jotham began to reign, and A. M. 3305, when Hezekiah died. One of his predictions is faid † to have faved the life of Jeremiah, who under the reign of Jehoiakim would have been put to death for prophefying the deftruction of the temple, had it not appeared that Micah had foretold the fame thing under Hezekiah above 100 years before ‡. Micah is mentioned as a prophet in the book of Jeremiah and in the New Teftament ||. He is imitated by fucceeding prophets (N), as he himfelf had borrowed expreffions from his predeceffors (O). Our Saviour himfelf fpoke in the language of this prophet (P).

† Jer. xxv. 15—24.

‡ *Jof. Ant.* lib. x. c. 7.

|| Micah iii. 12. Matt. ii. 5. John vii. 42.

75
His ftyle. The ftyle of Micah is for the moft part clofe, forcible, pointed, and concife; fometimes approaching the obfcurity of Hofea; in many parts animated and fublime; and in general truly poetical. In his prophecies there is an elegant poem, which Dr Lowth thinks is a citation from the anfwer of Balaam to the king of the Moabites:

Wherewith fhall I come before Jehovah?
Wherewith fhall I bow myfelf unto the High God?
Shall I come before him with burnt-offerings,
With calves of a year old?
Will Jehovah be pleafed with thoufands of rams?
With ten thoufands of rivers of oil?
Shall I give my firft-born for my tranfgreffion?
The fruit of my body for the fin of my foul?
He hath fhowed thee, O man, what is good:
And what doth Jehovah require of thee,
But to do juftice, and to love mercy,
And to be humble in walking with thy God?

76
Of Nahum. Jofephus afferts, that Nahum lived in the time of Jotham king of Judah; in which cafe he may be fuppofed to have prophefied againft Nineveh when Tiglath-Pilefer king of Affyria carried captive the natives of Galilee and other parts about A. M. 3264. It is, however, probable, that his prophecies were delivered in the reign of Hezekiah; for he appears to fpeak of the taking of No-Ammon a city of Egypt, and of the infolent meffengers of Sennacherib, as of things paft; and he likewife defcribes the people of Judah as ftill in their own country, and defirous of celebrating their feftivals.

While Jerufalem was threatened by Sennacherib, Nahum promifed deliverance to Hezekiah, and predicted that Judah would foon celebrate her folemn feafts fecure from invafion, as her enemy would no more difturb her peace. In the fecond and third chapters Nahum foretels the downfal of the Affyrian empire and the final deftruction of Nineveh, which was probably accomplifhed by the Medes and Babylonians, whofe combined forces overpowered the Affyrians by furprife "while they were folden together as thorns, and while they were drunken as drunkards," when the gates of the river were opened, the palace demolifhed, and an "overrunning flood" affifted the conquerors in their devaftation; who took an endlefs ftore of fpoil of gold and filver, making an utter end of the place of Nineveh, of that vaft and populous city, whofe walls were 100 feet high, and fo broad that three chariots could pafs abreaft. Yet fo completely was this celebrated city deftroyed, that even in the 2d century the fpot on which it ftood could not be afcertained, every veftige of it being gone.

It is impoffible to read of the exact accomplifhment of the prophetic denunciations againft the enemies of the Jews, without reflecting on the aftonifhing proofs which that nation enjoyed of the divine origin of their religion. From the Babylonifh captivity to the time of Chrift they had numberlefs inftances of the fulfilment of their prophecies.

The character of Nahum as a writer is thus defcribed by Dr Lowth: "None of the minor prophets feem to equal Nahum in boldnefs, ardour, and fublimity. His prophecy, too, forms a regular and perfect poem; the exordium is not merely magnificent, it is truly majeftic; the preparation for the deftruction of Nineveh, and the defcription of its downfal and defolation, are expreffed in the moft vivid colours, and are bold and luminous in the higheft degree."

77
Of Habakkuk. As the prophet Habakkuk makes no mention of the Affyrians, and fpeaks of the Chaldean invafions as near at hand, he probably lived after the deftruction of the Affyrian

(N) Compare Zephan. iii. 19. with Micah. iv. 7. and Ezek. xxii. 27. with Micah iii. 11.
(O) Compare Micah. iv. 1—3. and Ifaiah ii. 2—4. Micah iv. 13. with Ifaiah xli. 15.
(P) Compare Micah viii. 6. with Matt. x. 35, 36.

Scripture.

Aſſyrian empire in the fall of Nineveh A. M. 3392, and not long before the devaſtation of Judea by Nebuchadnezzar. Habakkuk was then nearly contemporary with Jeremiah, and predicted the ſame events. A general account of Habakkuk's prophecies has already been given under the word HABAKKUK, which may be conſulted. We ſhould, however, farther obſerve, that the prayer in the third chapter is a moſt beautiful and perfect ode, poſſeſſing all the fire of poetry and the profound reverence of religion.

God came from Teman,
And the Holy One from Mount Paran:
His glory covered the heavens,
And the earth was full of his praiſe.
His brightneſs was as the light;
Beams of glory iſſued from his ſide;
And there was the hiding of his power.
Before him went the peſtilence;
And burning coals went forth at his feet.
He ſtood and meaſured the earth;
He beheld and drove aſunder the nations;
The everlaſting mountains were ſcattered;
The perpetual hills did bow.

The prophet illuſtrates this ſubject throughout with equal ſublimity; ſelecting from ſuch an aſſemblage of miraculous incidents the moſt noble and important, diſplaying them in the moſt ſplendid colours, and embelliſhing them with the ſublimeſt imagery, figures, and diction; the dignity of which is ſo heightened and recommended by the ſuperior elegance of the concluſion, that were it not for a few ſhades which the hand of time has apparently caſt over it in two or three paſſages, no compoſition of the kind would appear more elegant or more perfect than this poem.

|| Heb. x. 37, 38. Rom. i. 17. Gal. iii. 2. Acts xiii. 41. compare with Hab. i. 5.

Habakkuk is imitated by ſucceeding prophets, and his words are borrowed by the evangelical writers ||.

78 Prophecies of Zephaniah.

Zephaniah, who was contemporary with Jeremiah, propheſied in the reign of Joſiah king of Judah; and from the idolatry which he deſcribes as prevailing at that time, it is probable that his prophecies were delivered before the laſt reformation made by that pious prince A. M. 3381.

The account which Zephaniah and Jeremiah give of the idolatries of their age is ſo ſimilar, that St Iſiodore aſſerts, that Zephaniah abridged the deſcriptions of Jeremiah. But it is more probable that the prophecies of Zephaniah were written ſome years before thoſe of his contemporary; for Jeremiah ſeems to repreſent the abuſes as partly removed which Zephaniah deſcribes as flagrant and exceſſive (q).

In the firſt chapter Zephaniah denounces the wrath of God againſt the idolaters who worſhipped Baal and the hoſt of heaven, and againſt the violent and deceitful. In the ſecond chapter the prophet threatens deſtruction to the Philiſtines, the Moabites, the Ammonites, and Ethiopians; and deſcribes the fate of Nineveh in emphatic terms: "Flocks ſhall lie down in the midſt of her; all the beaſts of the nations, both the cormorant and bittern, ſhall lodge in her: their voice ſhall ſing in the windows; deſolation ſhall be in the threſholds." In the third chapter the prophet inveighs againſt the pollutions and oppreſſions of the Jews; and concludes with the promiſe, "That a remnant would be ſaved, and that multiplied bleſſings would be beſtowed upon the penitent." The ſtyle of Zephaniah is poetical, but is not diſtinguiſhed by any peculiar elegance or beauty, though generally animated and impreſſive.

79 Of Haggai.

Haggai, the tenth of the minor prophets, was the firſt who flouriſhed among the Jews after the Babyloniſh captivity. He began to propheſy in the ſecond year of Darius Hyſtaſpes, about 520 years before Chriſt.

The intention of the prophecy of Haggai was to encourage the diſpirited Jews to proceed with the building of the temple. The only prediction mentioned refers to the Meſſiah, whom the prophet aſſures his countrymen would fill the new temple with glory. So well was this prediction underſtood by the Jews, that they looked with earneſt expectation for the Meſſiah's appearing in this temple till it was deſtroyed by the Romans. But as the victorious Meſſiah, whom they expected, did not then appear, they have ſince applied the prophecy to a third temple, which they hope to ſee reared in ſome future period.

The ſtyle of Haggai, in the opinion of Dr Lowth, is proſaic. Dr Newcome, on the contrary, thinks that a great part of it is poetical.

80 Of Zechariah.

Zechariah was undoubtedly a contemporary of Haggai, and began to propheſy two months after him, in the eighth month of the ſecond year of Darius Hyſtaſpes, A. M. 3484, being commiſſioned as well as Haggai to exhort the Jews to proceed in the building of the temple after the interruption which the work had ſuffered. We are informed by Ezra (vi. 14.), that the Jews proſpered through the propheſying of Zechariah and Haggai.

Zechariah begins with general exhortations to his countrymen, exciting them to repent from the evil ways of their fathers, whom the prophets had admoniſhed in vain. He deſcribes angels of the Lord interceding for mercy on Jeruſalem and the deſolate cities of Judah, which had experienced the indignation of the Moſt High for 70 years, while the neighbouring nations were at peace. He declares, that the houſe of the Lord ſhould be built in Jeruſalem, and that Zion ſhould be comforted. The prophet then repreſents the increaſe and proſperity of the Jews under ſeveral typical figures. He deſcribes the eſtabliſhment of the Jewiſh government and the coming of the Meſſiah. He admoniſhes thoſe who obſerved ſolemn faſts without due contrition, to execute juſtice, mercy, and compaſſion, every man to his brother; not to oppreſs the widow nor the fatherleſs, the ſtranger nor the poor. He promiſes, that God would again ſhow favour to Jeruſalem; that their mournful faſts ſhould be turned into cheerful feaſts; and that the church of the Lord ſhould be enlarged by the acceſſion of many nations.

The 12th verſe of the 11th chapter of this book, which exhibits a prophetic deſcription of ſome circumſtances afterwards fulfilled in our Saviour, appears to be

(q) Compare Zephaniah i. 4, 5, 9. with Jeremiah ii. 5, 20, 32.

Scripture. be cited by St Matthew (xxvii. 9, 10.) as ſpoken by Jeremiah; and as the 11th, 12th, and 13th chapters have been thought to contain ſome particulars more ſuitable to the age of Jeremiah than to that of Zechariah, ſome learned writers are of opinion that they were written by the former prophet, and have been from ſimilarity of ſubject joined by miſtake to thoſe of Zechariah. But others are of opinion, that St Matthew might allude to ſome traditional prophecy of Jeremiah, or, what is more probable, that the name of Jeremiah was ſubſtituted by miſtake in place of Zechariah.

The 12th, 13th, and 14th chapters contain prophecies which refer entirely to the Chriſtian diſpenſation; the circumſtances attending which he deſcribes with a clearneſs which indicated their near approach.

The ſtyle of Zechariah is ſo ſimilar to that of Jeremiah, that the Jews were accuſtomed to remark that the ſpirit of Jeremiah had paſſed into him. He is generally proſaic, till towards the concluſion of his work, when he becomes more elevated and poetical. The whole is beautifully connected by eaſy tranſitions, and preſent and future ſcenes are blended with the greateſt delicacy.

81
Of Malachi. Malachi was the laſt prophet that flouriſhed under the Jewiſh diſpenſation; but neither the time in which he lived, nor any particulars of his hiſtory, can now be aſcertained. It is even uncertain whether the word *Malachi* be a proper name, or denote, as the Septuagint have rendered it, *his angel* (R), that is, "the angel of the Lord." Origen ſuppoſed, that Malachi was an angel incarnate, and not a man. The ancient Hebrews, the Chaldee paraphraſt, and St Jerome, are of opinion he was the ſame perſon with Ezra: but if this was the caſe, they ought to have aſſigned ſome reaſon for giving two different names to the ſame perſon.

As it appears from the concurring teſtimony of all the ancient Jewiſh and Chriſtian writers, that the light of prophecy expired in Malachi, we may ſuppoſe that the termination of his miniſtry coincided with the accompliſhment of the firſt ſeven weeks of Daniel's prophecy, which was the period appointed for ſealing the viſion and prophecy. This, according to Prideaux's account, took place in A. M. 3595; but, according to the calculations of Biſhop Lloyd, to A. M. 3607, twelve years later. Whatever reckoning we prefer, it muſt be allowed that Malachi completed the canon of the Old Teſtament about 400 years before the birth of Chriſt.

It appears certain that Malachi propheſied under Nehemiah, and after Haggai and Zechariah, at a time when great diſorders reigned among the prieſts and people of Judah, which are reproved by Malachi. He inveighs againſt the prieſts (i. 6, &c. ii. 1, 2, &c.); he reproaches the people with having taken ſtrange wives (ii. 11.); he reproves them for their inhumanity towards their brethren (ii. 10. iii. 5.); their too frequently divorcing their wives: their neglect of paying their tithes and firſt-fruits (Mal. iii. 13.). He ſeems to allude to the covenant that Nehemiah renewed with the Lord (iii. 10. and ii. 4. 5, &c.). [illegible] by the prieſts and the chief of the nation. He ſpeaks of the ſacrifice of the new law, and of the abolition of thoſe of the old, in theſe words (i. 10, 11, 12, 13.): "I have no pleaſure in you, ſaith the Lord of hoſts, neither will I accept an offering at your hand. For from the riſing of the ſun, even unto the going down of the ſame, my name ſhall be great among the Gentiles, and in every place incenſe ſhall be offered unto my name, and a pure offering: for my name ſhall be great among the Heathen, ſaith the Lord of hoſts." He declares that the Lord was weary with the impiety of Iſrael; and aſſures them, that the Lord whom they ſought ſhould ſuddenly come to his temple preceded by the meſſenger of the covenant, who was to prepare his way; that the Lord when he appeared ſhould purify the ſons of Levi from their unrighteouſneſs, and refine them as metal from the droſs; and that then the offering of Judah, the ſpiritual ſacrifice of the heart, ſhould be pleaſant to the Lord. The prophet, like one who was delivering a laſt meſſage, denounces deſtruction againſt the impenitent in emphatic and alarming words. He encourages thoſe who feared the name of the Lord with the animating promiſe, that the "Sun of righteouſneſs ſhould ariſe with ſalvation in his rays," and render them triumphant over the wicked. And now that prophecy was to ceaſe, and miracles were no more to be performed till the coming of the Meſſiah; now that the Jews were to be left to the guidance of their own reaſon, and the written inſtructions of their prophets—Malachi exhorts them to remember the law of Moſes, which the Lord had revealed from Horeb for the ſake of all Iſrael. At length he ſeals up the prophecies of the Old Teſtament, by predicting the commencement of the new diſpenſation, which ſhould be uſhered in by John the Baptiſt with the power and ſpirit of Elijah; who ſhould turn the hearts of fathers and children to repentance; but if his admonitions ſhould be rejected, that the Lord would ſmite the land with a curſe.

82
New Teſtament. THE collection of writings compoſed after the aſcenſion of Chriſt, and acknowledged by his followers to be divine, is known in general by the name of καινη διαθηκη.

83
Title. This title, though neither given by divine command, nor applied to theſe writings by the apoſtles, was adopted in a very early age, though the preciſe time of its introduction is uncertain, it being juſtified by ſeveral paſſages in Scripture †, and warranted by the authority of St Paul in particular, who calls the ſacred books before the time of Chriſt παλαια διαθηκη ‡. Even long before that period, either the whole of the Old Teſtament, or the five books of Moſes, were entitled βιβλιον διαθηκης, or book of the covenant §.

† Matth. xxvi. 28. Gal. iii. 17. Heb. viii. 8. ix. 15—20.

‡ 2 Cor. iii.

§ 1 Mac. i. 57.

As the word διαθηκη admits of a two-fold interpretation, we may tranſlate this title either the *New Covenant* or *New Teſtament*. The former tranſlation muſt be adopted, if reſpect be had to the texts of Scripture, from which the name is borrowed, ſince thoſe paſſages evidently convey the idea of a covenant; and, beſides, a being incapable of death can neither have made an old nor make a new teſtament. It is likewiſe probable, that the earlieſt Greek diſciples, who made uſe of this expreſſion, had no other notion in view than that of covenant

(R) מלאכי *Malachi* ſignifies properly *my angel*.

venant. We, on the contrary, are accuſtomed to give this ſacred collection the name of *Teſtament;* and ſince it would be not only improper, but even abſurd, to ſpeak of the Teſtament of God, we commonly underſtand the Teſtament of Chriſt; an explanation which removes but half the difficulty, ſince the new only, and not the old, had Chriſt for its teſtator.

84
Importance of the argument from the authenticity of the books.

In ſtating the evidence for the truth of Chriſtianity, there is nothing more worthy of conſideration than the authenticity of the books of the New Teſtament. This is the foundation on which all other arguments reſt; and if it is ſolid, the Chriſtian religion is fully eſtabliſhed. The proofs for the authenticity of the New Teſtament have this peculiar advantage, that they are plain and ſimple, and involve no metaphyſical ſubtilties.—Every man who can diſtinguiſh truth from falſehood muſt ſee their force; and if there are any ſo blinded by prejudice, or corrupted by licentiouſneſs, as to attempt by ſophiſtry to elude them, their ſophiſtry will be eaſily detected by every man of common underſtanding, who has read the hiſtorical evidence with candour and attention. Inſtead, therefore, of declaiming againſt the infidel, we ſolicit his attention to this ſubject, convinced, that where truth reſides, it will ſhine with ſo conſtant and clear a light, that the combined ingenuity of all the deiſts ſince the beginning of the world will never be able to extinguiſh or to obſcure it. If the books of the New Teſtament are really genuine, oppoſition will incite the Chriſtian to bring forward the evidence; and thus by the united efforts of the deiſt and the Chriſtian, the arguments will be ſtated with all the clearneſs and accuracy of which they are ſuſceptible in ſo remarkable a degree.

It is ſurpriſing that the adverſaries of Chriſtianity have not always made their firſt attacks in this quarter; for if they admit that the writings of the New Teſtament are as ancient as we affirm, and compoſed by the perſons to whom they are aſcribed, they muſt allow, if they reaſon fairly, that the Chriſtian religion is true.

The apoſtles frequently allude in their epiſtles to the gift of miracles, which they had communicated to the Chriſtian converts by the impoſition of hands, in confirmation of the doctrine delivered in their ſpeeches and writings, and ſometimes to miracles which they themſelves had performed. Now if theſe epiſtles are really genuine, it is hardly poſſible to deny thoſe miracles to be true. The caſe is here entirely different from that of an hiſtorian, who relates extraordinary events in the courſe of his narrative, ſince either credulity or an actual intention to deceive may induce him to deſcribe as true a ſeries of falſehoods reſpecting a foreign land or diſtant period. Even to the Evangeliſts might an adverſary of the Chriſtian religion make this objection: but to write to perſons with whom we ſtand in the neareſt connection, "I have not only performed miracles in your preſence, but have likewiſe communicated to you the ſame extraordinary endowments," to write in this manner, if nothing of the kind had ever happened, would require ſuch an incredible degree of effrontery, that he who poſſeſſed it would not only expoſe himſelf to the utmoſt ridicule, but by giving his adverſaries the faireſt opportunity to detect his impoſture, would ruin the cauſe which he attempted to ſupport.

Michaelis's Introduction to the New Teſtament.

St Paul's Firſt Epiſtle to the Theſſalonians is addreſſed to a community to which he had preached the goſpel only three Sabbath days, when he was forced to quit it by the perſecution of the populace. In this epiſtle he appeals to the miracles which he had performed, and to the gifts of the Holy Spirit which he had communicated. Now, is it poſſible, without forfeiting all pretenſions to common ſenſe, that, in writing to a community which he had lately eſtabliſhed, he could ſpeak of miracles performed, and gifts of the Holy Ghoſt communicated, if no member of the ſociety had ſeen the one, or received the other?

To ſuppoſe that an impoſtor could write to the converts or adverſaries of the new religion ſuch epiſtles as theſe, with a degree of triumph over his opponents, and yet maintain his authority, implies ignorance and ſtupidity hardly to be believed. Credulous as the Chriſtians have been in later ages, and even ſo early as the third century, no leſs ſevere were they in their inquiries, and guarded againſt deception, at the introduction of Chriſtianity. This character is given them even by Lucian, a writer of the ſecond century, who vented his ſatire not only againſt certain Chriſtians *, who had ſupplied Peregrinus with the means of ſubſiſtence, but alſo againſt heathen oracles and pretended wonders. He relates of his impoſtor (Pſeudomantis), that he attempted nothing ſupernatural in the preſence of the Chriſtians and Epicureans. This Pſeudomantis exclaims before the whole aſſembly, "Away with the Chriſtians, away with the Epicureans, and let thoſe only remain who believe in the Deity!" (πιστευοντες τῳ Θεῳ) on which the populace took up ſtones to drive away the ſuſpicious; while the other philoſophers, Pythagoreans, Platoniſts, and Stoics, as credulous friends and protectors of the cauſe, were permitted to remain †.

* *De morte Peregrini,* § 12, 13, 16. *Ed. Reitz.* tom. iii. p. 334—338. 341.

† *Alexander ſeu Pſeudomantis,* § 25, 32. tom. ii. p. 232, 233, 244, 245.

It is readily acknowledged, that the arguments drawn from the authenticity of the New Teſtament only eſtabliſh the truth of the miracles performed by the apoſtles, and are not applicable to the miracles of our Saviour; yet, if we admit the firſt three goſpels to be genuine, the truth of the Chriſtian religion will be proved from the prophecies of Jeſus. For if theſe goſpels were compoſed by Matthew, Mark, and Luke, at the time in which all the primitive Chriſtians affirm, that is, previous to the deſtruction of Jeruſalem, they muſt be inſpired; for they contain a circumſtantial prophecy of the deſtruction of Jeruſalem, and determine the period at which it was accompliſhed. Now it was impoſſible that human ſagacity could foreſee that event; for when it was predicted nothing was more improbable. The Jews were reſolved to avoid an open rebellion, well knowing the greatneſs of their danger, and ſubmitted to the oppreſſions of their governors in the hope of obtaining redreſs from the court of Rome.—The circumſtance which gave birth to theſe misfortunes is ſo trifling in itſelf, that independent of its conſequences, it would not deſerve to be recorded. In the narrow entrance to a ſynagogue in Cæſarea, ſome perſon had made an offering of birds merely with a view to irritate the Jews. The inſult excited their indignation, and occaſioned the ſhedding of blood. Without this trifling accident, which no human wiſdom could foreſee even the day before it happened, it is poſſible that the prophecy of Jeſus would never have been

fulfilled;

Scripture. fulfilled. But Florus, who was then procurator of Judea, converted this private quarrel into public hostilities, and compelled the Jewish nation to rebel contrary to its wish and resolution, in order to avoid what the Jews had threatened, an impeachment before the Roman emperor for his excessive cruelties. But even after this rebellion had broken out, the destruction of the temple was a very improbable event. It was not the practice of the Romans to destroy the magnificent edifices of the nations which they subdued; and of all the Roman generals, none was more unlikely to demolish so ancient and august a building as Titus Vespasian.

So important then is the question, Whether the books of the New Testament be genuine? that the arguments which prove their authenticity, prove also the truth of the Christian religion. Let us now consider the evidence which proves the authenticity of the New Testament.

85 Their authenticity proved.

We receive the books of the New Testament as the genuine works of Matthew, Mark, Luke, John, and Paul, for the same reason that we receive the writings of Xenophon, of Polybius, of Plutarch, of Cæsar, and of Livy. We have the uninterrupted testimony of all ages, and we have no reason to suspect imposition. This argument is much stronger when applied to the books of the New Testament than when applied to any other writings; for they were addressed to large societies, were often read in their presence, and acknowledged by them to be the writings of the apostles.— Whereas, the most eminent profane writings which still remain were addressed only to individuals, or to no persons at all: and we have no authority to affirm that they were read in public; on the contrary, we know that a liberal education was uncommon; books were scarce, and the knowledge of them was confined to a few individuals in every nation.

The New Testament was read over three quarters of the world, while profane writers were limited to one nation or to one country. An uninterrupted succession of writers from the apostolic ages to the present time quote the sacred writings, or make allusions to them: and these quotations and allusions are made not only by friends but by enemies. This cannot be asserted of even the best classic authors. And it is highly probable, that the translations of the New Testament were made so early as the second century; and in a century or two after, they became very numerous. After this period, it was impossible to forge new writings, or to corrupt the sacred text, unless we can suppose that men of different nations, of different sentiments and different languages, and often exceedingly hostile to one another, should all agree in one forgery. This argument is so strong, that if we deny the authenticity of the New Testament, we may with a thousand times more propriety reject all the other writings in the world: we may even throw aside human testimony itself. But as this subject is of great importance, we shall consider it at more length; and to enable our readers to judge with the greater accuracy, we shall state, from the valuable work of Michaelis, as translated by the judicious and learned Mr Marsh, the reasons which may induce a critic to suspect a work to be spurious.

86 Negatively.

1. When doubts have been made from its first appearance in the world, whether it proceeded from the author to whom it is ascribed. 2. When the immediate friends of the pretended author, who were able to decide upon the subject, have denied it to be his production. 3. When a long series of years has elapsed after his death, in which the book was unknown, and in which it must unavoidably have been mentioned and quoted, had it really existed. 4. When the style is different from that of his other writings, or, in case no other remain, different from that which might reasonably be expected. 5. When events are recorded which happened later than the time of the pretended author. 6. When opinions are advanced which contradict those he is known to maintain in his other writings. Though this latter argument alone leads to no positive conclusion, since every man is liable to change his opinion, or through forgetfulness to vary in the circumstances of the same relation, of which Josephus, in his Antiquities and War of the Jews, affords a striking example.

87 The reasons that would prove a book to be spurious.

88 Do not apply to the New Testament.

1. But it cannot be shown that any one doubted of its authenticity in the period in which it first appeared. 2. No ancient accounts are on record whence we may conclude it to be spurious. 3. No considerable period elapsed after the death of the apostles, in which the New Testament was unknown; but, on the contrary, it is mentioned by their very contemporaries, and the accounts of it in the second century are still more numerous. 4. No argument can be brought in its disfavour from the nature of the style, it being exactly such as might be expected from the apostles, not Attic but Jewish Greek. 5. No facts are recorded which happened after their death. 6. No doctrines are maintained which contradict the known tenets of the authors, since, beside the New Testament, no writings of the apostles exist. But, to the honour of the New Testament be it spoken, it contains numerous contradictions to the tenets and doctrines of the fathers in the second and third century, whose morality was different from that of the gospel, which recommends fortitude and submission to unavoidable evils, but not that enthusiastic ardour for martyrdom for which those centuries are distinguished; it alludes to ceremonies which in the following ages were either in disuse or totally unknown: all which circumstances infallibly demonstrate that the New Testament is not a production of either of those centuries.

89 Positively.

We shall now consider the positive evidence for the authenticity of the New Testament. These may be arranged under the three following heads:

1. The impossibility of a forgery, arising from the nature of the thing itself. 2. The ancient Christian, Jewish, and Heathen testimony in its favour. 3. Its own internal evidence.

90 Impossibility of a forgery arising from the nature of the thing

1. The impossibility of a forgery arising from the nature of the thing itself is evident. It is impossible to establish forged writings as authentic in any place where there are persons strongly inclined and well qualified to detect the fraud. Now the Jews were the most violent enemies of Christianity. They put the founder of it to death; they persecuted his disciples with implacable fury; and they were anxious to stifle the new religion in its birth. If the writings of the New Testament had been forged, would not the Jews have detected the imposture? Is there a single instance on record where a few individuals have imposed a history upon the world against

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against the testimony of a whole nation? Would the inhabitants of Palestine have received the gospels, if they had not had sufficient evidence that Jesus Christ really appeared among them, and performed the miracles ascribed to him? Or would the churches of Rome or of Corinth have acknowledged the epistles addressed to them as the genuine works of Paul, if Paul had never preached among them? We might as well think to prove, that the history of the Reformation is the invention of historians; and that no revolution happened in Great Britain during the last century.

91 From testimony.

2. The second kind of evidence which we produce to prove the authenticity of the New Testament, is the testimony of ancient writers, Christians, Jews, and Heathens.

In reviewing the evidence of testimony, it will not be expected that we should begin at the present age, and trace backwards the authors who have written on this subject to the first ages of Christianity. This indeed, though a laborious task, could be performed in the most complete manner; the whole series of authors, numerous in every age, who have quoted from the books of the New Testament, written commentaries upon them, translated them into different languages, or who have drawn up a list of them, could be exhibited so as to form such a perfect body of evidence, that we imagine even a jury of deists would find it impossible, upon a deliberate and candid examination, to reject or disbelieve it. We do not, however, suppose that scepticism has yet arrived at so great a height as to render such a tedious and circumstantial evidence necessary. Passing over the intermediate space, therefore, we shall ascend at once to the fourth century, when the evidence for the authenticity of the New Testament was fully established, and trace it back from that period to the age of the apostles. We hope that this method of stating the evidence will appear more natural, and will afford more satisfaction, than that which has been usually adopted.

It is surely more natural, when we investigate the truth of any fact which depends on a series of testimony, to begin with those witnesses who lived nearest the present age, and whose characters are best established. In this way we shall learn from themselves the foundation of their belief, and the characters of those from whom they derived it; and thus we ascend till we arrive at its origin. This mode of investigation will give more satisfaction to the deist than the usual way; and we believe no Christian, who is confident of the goodness of his cause, will be unwilling to grant any proper concessions. The deist will thus have an opportunity of examining, separately, what he will consider as the weakest parts of the evidence, those which are exhibited by the earliest Christian writers, consisting of expressions, and not quotations, taken from the New Testament. The Christian, on the other hand, ought to wish, that these apparently weak parts of the evidence were distinctly examined, for they will afford an irrefragable proof that the New Testament was not forged: and should the deist reject the evidence of those early writers, it will be incumbent on him to account for the origin of the Christian religion, which he will find more difficult than to admit the common hypothesis.

In the fourth century we could produce the testimonies of numerous witnesses to prove that the books of the New Testament existed at that time; but it will be sufficient to mention their names, the time in which they wrote, and the substance of their evidence. This we shall present in a concise form in the following table, which is taken from Jones's New and Full Method of establishing the canon of the New Testament.

The Names of the Writers.	*Times in which they lived.*	*The variation or agreement of their catalogues with ours now received.*	*The books in which these catalogues are.*
I. Athanasius bishop of Alexandria.	A. C. 315.	The same perfectly with ours now received.	*Fragment. Epist. Testal.* tom. ii. *in Synops.* tom. i.
II. Cyril bishop of Jerusalem.	340.	The same with ours, only the Revelation is omitted.	*Catech. IV.* § *ult.* p. 101.
III. The bishops assembled in the council of Laodicea.	364.	The Revelation is omitted.	*Canon LIX.* N. B. The Canons of this council were not long afterwards received into the body of the canons of the universal church.
IV. Epiphanius bishop of Salamis in Cyprus.	370.	The same with ours now received.	*Hæres.* 76. *cont. Anom.* p. 399.
V. Gregory Nazianzen bishop of Constantinople.	375.	s the Revelation.	*Carm. de veris et genuin. Scriptur.*

Scripture.

The Names of the Writers.	Times in which they lived.	The variation or agreement of their catalogues with ours now received.	The books in which these catalogues are.
VI. Philastrius bishop of Brixia in Venice.	380.	The same with ours now received; except that he mentions only 13 of St Paul's epistles (omitting very probably the Epistle to the Hebrews), and leaves out the Revelations.	*Lib. de Hæres. Numb.* 87.
VII. Jerome.	382.	The same with ours; except that he speaks dubiously of the Epistle to the Hebrews; though in other parts of his writings he receives it as canonical.	*Ep. ad Paulin. Tract.* 6. p. 2. Also commonly prefixed to the Latin vulgar.
VIII. Ruffin presbyter of Aquilegium.	390.	It perfectly agrees with ours.	*Expos. in Symb. Apostol.* § 36. *int. Ep. Hieron. Par.* 1. *Tract.* 3. p. 110. *et inter Op. Cypr.* p. 575.
IX. Austin bishop of Hippo in Africa.	394.	It perfectly agrees with ours.	*De Doctrin. Christ.* lib. ii. c. 8. *Tom. Op.* 3. p. 25.
X. The XLIV bishops assembled in the third council of Carthage.	St Austin was present at it.	It perfectly agrees with ours.	*Vid. Canon XLVII. et cap. ult.*

92 Testimonies of the ancient Christians.

We now go back to Eusebius, who wrote about the year 315, and whose catalogue of the books of the New Testament we shall mention at more length. "Let us observe (says he) the writings of the apostle John, which are *uncontradicted*; and, first of all, must be mentioned, as acknowledged of all, the gospel, according to him, well known to all the churches under heaven." The author then proceeds to relate the occasions of writing the gospels, and the reasons for placing St John's the last, manifestly speaking of all the four as equal in their authority, and in the certainty of their original. The second passage is taken from a chapter, the title of which is, "Of the Scriptures universally acknowledged, and of those that are not such." Eusebius begins his enumeration in the following manner: "In the first place, are to be ranked the sacred four Gospels, then the book of the Acts of the Apostles; after that are to be reckoned the epistles of Paul: in the next place, that called the first Epistle of John and the Epistle of Peter are to be esteemed authentic: after this is to be placed, if it be thought fit, the Revelation of John; about which we shall observe the different opinions at proper seasons. Of the controverted, but yet well known or approved by the most, are that called the Epistle of James and that of Jude, the second of Peter, and the second and third of John, whether they were written by the evangelist or by another of the same name." He then proceeds to reckon up five others, not in our canon, which he calls in one place *spurious*, in another *controverted*; evidently meaning the same thing by these two words (s).

Paley's Evidences of Christianity.

93 Of Eusebius.

94 Of Victorin.

A. D. 290, Victorin bishop of Pettaw in Germany, in a commentary upon this text of the Revelation, "The first was like a lion, the second was like a calf, the third like a man, and the fourth like a flying eagle," makes out, that by the four creatures are intended the four gospels; and to show the propriety of the symbols, he recites the subject with which each evangelist opens his history. The explication is fanciful, but the testimony positive. He also expressly cites the Acts of the Apostles.

95 Of Cyprian.

A. D. 230, Cyprian bishop of Carthage gives the following testimony: "The church (says this father) is watered like Paradise by four rivers, that is, by four gospels." The Acts of the Apostles are also frequently quoted by Cyprian under that name, and under the name of the *Divine Scriptures*." In his various writings are such frequent and copious citations of Scripture, as to place this part of the testimony beyond controversy. Nor is there, in the works of this eminent African bishop, one quotation of a spurious or apocryphal Christian writing."

96 Of Origen.

A. D. 210, Origen is a most important evidence. Nothing can be more peremptory upon the subject now under

(s) That Eusebius could not intend, by the word rendered *spurious*, what we at present mean by it, is evident from a clause in this very chapter, where, speaking of the Gospels of Peter and Thomas, and Matthias and some others, he says, "They are not so much as to be reckoned among the *spurious*, but are to be rejected as altogether absurd and impious." *Lard. Cred.* vol. viii. p. 98.

Scripture. under consideration, and, from a writer of his learning and information, nothing more satisfactory, than the declaration of Origen, preserved in an extract of his works by Eusebius: "That the four gospels alone are received without dispute by the whole church of God under heaven:" to which declaration is immediately subjoined a brief history of the respective authors, to whom they were then, as they are now, ascribed. The sentiments expressed concerning the gospels in all the works of Origen which remain, entirely correspond with the testimony here cited. His attestation to the Acts of the Apostles is no less positive: "And Luke also once more sounds the trumpet relating the Acts of the Apostles." That the Scriptures were then universally read, is plainly affirmed by this writer in a passage in which he is repelling the objections of Celsus, "That it is not in private books, or such as are read by few only, and those studious persons, but in books read by every body, that it is written, The invisible things of God from the creation of the world are clearly seen, being understood by things that are made." It is to no purpose to single out quotations of Scripture from such a writer as this. We might as well make a selection of the quotations of Scripture in Dr Clarke's sermons. They are so thickly sown in the works of Origen, that Dr Mill says, "If we had all his works remaining, we should have before us almost the whole text of the Bible."

97 Of Tertullian. A. D. 194, Tertullian exhibits the number of the gospels then received, the names of the evangelists, and their proper designations, in one short sentence.— "Among the apostles, John and Matthew teach us the faith; among apostolical men, Luke and Mark refresh it." The next passage to be taken from Tertullian affords as complete an attestation to the authenticity of the gospels as can be well imagined. After enumerating the churches which had been founded by Paul at Corinth, in Galatia, at Philippi, Thessalonica, and Ephesus, the church of Rome established by Peter and Paul, and other churches derived from John, he proceeds thus: "I say then, that with them, but not with them only which are apostolical, but with all who have fellowship with them in the same faith, is that gospel of Luke received from its first publication, which we so zealously maintain;" and presently afterwards adds, "The same authority of the apostolical churches will support the other gospels, which we have from them, and according to them, I mean John's and Matthew's, although that likewise which Mark published may be said to be Peter's, whose interpreter Mark was." In another place Tertullian affirms, that the three other gospels, as well as St Luke's, were in the hands of the churches from the beginning. This noble testimony proves incontestably the antiquity of the gospels, and that they were universally received; that they were in the hands of all, and had been so from the first. And this evidence appears not more than 150 years after the publication of the books. Dr Lardner observes, "that there are more and larger quotations of the small volume of the New Testament in this one Christian author, than there are of all the works of Cicero, in writers of all characters, for several ages."

98 Of Irenæus. A. D. 178, Irenæus was bishop of Lyons, and is mentioned by Tertullian, Eusebius, Jerome, and Photius. In his youth he had been a disciple of Polycarp, who was a disciple of John. He asserts of himself and his contemporaries, that they were able to reckon up in all the principal churches the succession of bishops to their first institution. His testimony to the four gospels and Acts of the Apostles is express and positive. "We have not received," says Irenæus, "the knowledge of the way of our salvation by any others than those by whom the gospel has been brought to us. Which gospel they first preached, and afterwards by the will of God, committed to writing, that it might be for time to come the foundation and pillar of our faith. For after that our Lord rose from the dead, and they (the apostles) were endowed from above with the power of the Holy Ghost coming down upon them, they received a perfect knowledge of all things. They then went forth to all the ends of the earth, declaring to men the blessing of heavenly peace, having all of them, and every one alike, the gospel of God. Matthew then, among the Jews, wrote a gospel in their own language, while Peter and Paul were preaching the gospel at Rome, and founding a church there. And after their exit, Mark also, the disciple and interpreter of Peter, delivered to us in writing the things that had been preached by Peter. And Luke, the companion of Paul, put down in a book the gospel preached by him (Paul). Afterwards John, the disciple of the Lord, who also leaned upon his breast, likewise published a gospel while he dwelt at Ephesus in Asia." Irenæus then relates how Matthew begins his gospel, how Mark begins and ends his, and gives the supposed reasons for doing so. He enumerates at length all the passages of Christ's history in Luke, which are not found in any of the other evangelists. He states the particular design with which St John composed his gospel, and accounts for the doctrinal declarations which precede the narrative. If any modern divine should write a book upon the genuineness of the gospels, he could not assert it more expressly, or state their original more distinctly, than Irenæus hath done within little more than 100 years after they were published.

Respecting the book of the Acts of the Apostles, and its author, the testimony of Irenæus is no less explicit. Referring to the account of St Paul's conversion and vocation, in the ninth chapter of that book, "Nor can they (says he, meaning the parties with whom he argues) show that he is not to be credited, who has related to us the truth with the greatest exactness." In another place, he has actually collected the several texts, in which the writer of the history is represented as accompanying St Paul, which led him to exhibit a summary of almost the whole of the last twelve chapters of the book.

According to Lardner, Irenæus quotes twelve of Paul's epistles, naming their author; also the first epistle of Peter, the two first epistles of John, and the Revelation. The epistles of Paul which he omits are those addressed to Philemon and the Hebrews. Eusebius says, that he quotes the epistle to the Hebrews, though he does not ascribe it to Paul. The work, however, is lost.

A. D. 172, Tatian, who is spoken of by Clemens Alexandrinus, Origen, Eusebius, and Jerome, composed a harmony of the four gospels, which he called *Diatessaron* of the four. This title, as well as the work, is remarkable, 99 Of Tatian.

Scripture. markable, becauſe it ſhows that then as well as now there were four, and only four, goſpels in general uſe among Chriſtians.

A. D. 170, the churches of Lyons and Vienne in France ſent an account of the ſufferings of their martyrs to the churches of Aſia and Phrygia, which has been preſerved entire by Euſebius. And what carries in ſome meaſure the teſtimony of theſe churches to a higher age is, that they had now for their biſhop Pothinus, who was 90 years old, and whoſe early life conſequently muſt have immediately followed the times of the apoſtles. In this epiſtle are exact references to the goſpels of Luke and John, and to the Acts of the Apoſtles. The form of reference is the ſame as in all the preceding articles. That from St John is in theſe words: "Then was fulfilled that which was ſpoken by the Lord, that whoſoever killeth you, will think that he doth God ſervice *."

* John xvi. 2.

Diſtinct references are alſo made to other books, viz. Acts, Romans, Epheſians, Philippians, 1 Timothy, 1 Peter, 1 John, Revelation.

100 Of Juſtin Martyr.

A. D. 140, Juſtin Martyr compoſed ſeveral books, which are mentioned by his diſciple Tatian, by Tertullian, Methodius, Euſebius, Jerome, Epiphanius, and Photius. In his writings between 20 and 30 quotations from the goſpels and Acts of the Apoſtles are reckoned up, which are clear, diſtinct, and copious; if each verſe be counted ſeparately, a much greater number; if each expreſſion, ſtill more. Jones, in his book on the Canon of the New Teſtament, ventures to affirm that he cites the books of which it conſiſts, particularly the four goſpels, above 200 times.

We meet with quotations of three of the goſpels within the compaſs of half a page; "and in other words, he ſays, Depart from me into outer darkneſs, which the Father hath prepared for Satan and his Angels," (which is from Matthew xxv. 41.). "And again he ſaid in other words, I give unto you power to tread upon ſerpents and ſcorpions, and venomous beaſts, and upon all the power of the enemy." (This from Luke x. 19.). "And, before he was crucified, he ſaid, The ſon of man muſt ſuffer many things, and be rejected of the Scribes and Phariſees, and be crucified, and riſe again the third day." (This from Mark viii. 31.).

All the references in Juſtin are made without mentioning the author; which proves that theſe books were perfectly well known, and that there were no other accounts of Chriſt then extant, or, at leaſt, no others ſo received and credited as to make it neceſſary to add any marks of diſtinction. But although Juſtin mentions not the authors names, he calls the books *Memoirs compoſed by the Apoſtles; Memoirs compoſed by the Apoſtles and their Companions;* which deſcriptions, the latter eſpecially, exactly ſuit the titles which the Goſpels and Acts of the Apoſtles now bear.

He informs us, in his firſt apology, that *the Memoirs of the Apoſtles*, or the writings of the prophets, are read according as the time allows; and, when the reader has ended, the preſident makes a diſcourſe, exhorting to the imitation of ſuch excellent things.

A few ſhort obſervations will ſhow the value of this teſtimony. 1. The Memoirs of the Apoſtles, Juſtin in another place expreſsly tells us are what are called *goſpels.* And that they were the goſpels which we now uſe is made certain by Juſtin's numerous quotations of them, and his ſilence about any others. 2. He deſcribes the general uſage of the Chriſtian church. 3. He does not ſpeak of it as recent or newly inſtituted, but in the terms in which men ſpeak of eſtabliſhed cuſtoms.

Juſtin alſo makes ſuch alluſions to the following books as ſhews that he had read them: Romans, 1 Corinthians, Galatians, Epheſians, Philippians, Coloſſians, 2 Theſſalonians, Hebrews, 2 Peter; and he aſcribes the Revelation to John the Apoſtle of Chriſt.

101 Of Papias.

A. D. 116, Papias, a hearer of John, and companion of Polycarp, as Irenæus atteſts, and of the apoſtolical age as all agree, in a paſſage quoted by Euſebius, from a work now loſt, expreſsly aſcribes the two firſt goſpels to Matthew and Mark; and in a manner which proves that theſe goſpels muſt have publicly borne the names of theſe authors at that time, and probably long before; for Papias does not ſay, that one goſpel was written by Matthew, and another by Mark; but, aſſuming this as perfectly well known, he tells us from what materials Mark collected his account, viz. from Peter's preaching, and in what language Matthew wrote, viz. in Hebrew. Whether Papias was well informed in this ſtatement or not, to the point for which this teſtimony is produced, namely, that theſe books bore theſe names at this time, his authority is complete.

Papias himſelf declares that he received his accounts of Chriſtianity from thoſe who were acquainted with the apoſtles, and that thoſe accounts which he thus received from the older Chriſtians, and had committed to memory, he inſerted in his books. He farther adds, that he was very ſolicitous to obtain every poſſible information, eſpecially to learn what the apoſtles ſaid and preached, valuing ſuch information more than what was written in books *.

* *Præfat. in Op. apud. Euſeb. Hiſt. Ecl.* lib. iii. c. 39.

A. D. 108, Polycarp was the biſhop of Smyrna, and diſciple of John the Apoſtle. This teſtimony concerning Polycarp is given by Irenæus, who in his youth had ſeen him. "I can tell the place," ſaith Irenæus, "in which the bleſſed Polycarp ſat and taught, and his going out and coming in, and the manner of his life, and the form of his perſon, and the diſcourſes he made to the people, and how he related his converſation with John and others who had ſeen the Lord, and how he related their ſayings, and what he had heard concerning the Lord, both concerning his miracles and his doctrine, as he had received them from the eye-witneſſes of the word of life; all which Polycarp related agreeable to the ſcriptures."

102 Of Polycarp.

Of Polycarp, whoſe proximity to the age and country and perſons of the apoſtles is thus atteſted, we have one undoubted epiſtle remaining; which, though a ſhort performance, contains nearly 40 clear alluſions to the books of the New Teſtament. This is ſtrong evidence of the reſpect which was paid to them by Chriſtians of that age. Amongſt theſe, although the writings of St Paul are more frequently uſed by Polycarp than other parts of ſcripture, there are copious alluſions to the goſpel of St Matthew, ſome to paſſages found in the goſpels both of Matthew and Luke, and ſome which more nearly reſemble the words in Luke.

He thus fixes the authority of the Lord's Prayer, and the uſe of it among Chriſtians. If, therefore, we pray the

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the Lord to *forgive us*, *we ought alſo to forgive*. And again, With ſupplication *beſeeching* the all-ſeeing God *not to lead us into temptation*.

In another place, he quotes the words of our Lord: "But remembering what the Lord ſaid, teaching, Judge not, that ye be not judged. Forgive, and ye ſhall be forgiven; be ye merciful, that ye may obtain mercy; with what meaſure ye mete, it ſhall be meaſured to you again *. Suppoſing Polycarp to have had theſe words from the books in which we now find them, it is manifeſt that theſe books were conſidered by him, and by his readers, as he thought, as authentic accounts of Chriſt's diſcourſes; and that this point was inconteſtable.

* Mat. vii. 1. 2.

He quotes alſo the following books, the firſt of which he aſcribes to St Paul: 1 Corinthians, Epheſians, Philippians, 1 and 2 Theſſalonians; and makes evident references to others, particularly to Acts, Romans, 2 Corinthians, Galatians, 1 Timothy, 2 Timothy, 1 Peter, 1 John.

103
Of Ignatius.

Ignatius, as it is teſtified by ancient Chriſtian writers, became biſhop of Antioch about 37 years after Chriſt's aſcenſion; and therefore, from his time, and place, and ſtation, it is probable that he had known and converſed with many of the apoſtles. Epiſtles of Ignatius are referred to by Polycarp his contemporary. Paſſages, found in the epiſtles now extant under his name, are quoted by Irenæus, A. D. 178, by Origen, A. D. 230; and the occaſion of writing them is fully explained by Euſebius and Jerome. What are called the ſmaller epiſtles of Ignatius are generally reckoned the ſame which were read by Irenæus, Origen, and Euſebius.

They are admitted as genuine by Voſſius, and have been proved to be ſo by Biſhop Pearſon with a force of argument which ſeems to admit of no reply. In theſe epiſtles are undoubted alluſions to Matt. iii. 15. xi. 16. to John iii. 8.; and their venerable author, who often ſpeaks of St Paul in terms of the higheſt reſpect, once quotes his epiſtle to the Epheſians by *name*.

104
Of Hermas.

Near the concluſion of the epiſtle to the Romans, St Paul, amongſt others, ſends the following ſalutation: —"Salute Aſyncritus, Phlegon, *Hermas*, Patrobus, Hermes, and the brethren which are with them." Of Hermas, who appears in this catalogue of Roman Chriſtians as contemporary with St Paul, there is a book ſtill remaining, the authenticity of which cannot be diſputed. It is called the *Shepherd*, or *Paſtor of Hermas*. Its antiquity is inconteſtable, from the quotations of it in Irenæus, A. D. 178, Clement of Alexandria, A. D. 194, Tertullian, A. D. 200, Origen, A. D. 230. The notes of time extant in the epiſtle itſelf agree with its title, and with the teſtimonies concerning it, which intimate that it was written during the lifetime of Clement. In this piece are tacit alluſions to St Matthew's, St Luke's, and St John's goſpels; that is to ſay, there are applications of thoughts and expreſſions found in theſe goſpels, without citing the place or writer from which they were taken. In this form appear in Hermas the confeſſing and denying of Chriſt †; the parable of the ſeed ſown; ‡ the compariſon of Chriſt's diſciples to little children; the ſaying, "he that putteth away his wife, and marrieth another, committeth adultery §;" the ſingular expreſſion, "having received all power from his Father," is probably an alluſion to Matt. xxviii. 18. and Chriſt being the "gate," or only way of coming "to God," is a plain alluſion to John xiv. 6. x. 7. 9. There is alſo a probable alluſion to Acts v. 32.

† Matt. x. 32, 33, or Luke xii. 8, 9.
‡ Matt. xiii. 3, or Luke viii. 5.
§ Luke xvi. 18.

The Shepherd of Hermas has been conſidered as a fanciful performance. This, however, is of no importance in the preſent caſe. We only adduce it as evidence that the books to which it frequently alludes exiſted in the firſt century; and for this purpoſe it is ſatisfactory, as its authenticity has never been queſtioned. However abſurd opinions a man may entertain while he retains his underſtanding, his teſtimony to a matter of fact will ſtill be received in any court of juſtice.

105
Of Clemens Romanus.

A. D. 96, we are in poſſeſſion of an epiſtle written by Clement biſhop of Rome, whom ancient writers, without any ſcruple, aſſert to have been the Clement whom St Paul mentions Philippians iv. 3. "with Clement alſo, and other my fellow labourers, whoſe names are in the book of life." This epiſtle is ſpoken of by the ancients as an epiſtle acknowledged by all; and, as Irenæus well repreſents its value, "written by Clement, who had ſeen the bleſſed apoſtles and converſed with them, who had the preaching of the apoſtles ſtill ſounding in his ears, and their traditions before his eyes." It is addreſſed to the church of Corinth; and what alone may ſeem a deciſive proof of its authenticity, Dionyſius biſhop of Corinth, about the year 170, i. e. about 80 or 90 years after the epiſtle was written, bears witneſs, "that it had been uſually read in that church from ancient times." This epiſtle affords, amongſt others, the following valuable paſſages: "Eſpecially remembering the words of the Lord Jeſus, which he ſpake, teaching gentleneſs and long ſuffering; for thus he ſaid (T), Be ye merciful, that ye may obtain mercy; forgive, that it may be forgiven unto you; as you do, ſo ſhall it be done unto you; as you give, ſo ſhall it be given unto you; as ye judge, ſo ſhall ye be judged; as ye ſhew kindneſs, ſo ſhall kindneſs be ſhewn unto you; with what meaſure ye mete, with the ſame it ſhall be meaſured to you. By this command, and by theſe rules, let us eſtabliſh ourſelves, that we may always walk obediently to his holy words."

Again, "Remember the words of the Lord Jeſus, for he ſaid, Wo to that man by whom offences come; it were better for him that he had not been born, than that he ſhould offend one of my elect; it were better for him that a millſtone ſhould be tied about his neck, and that he ſhould be drowned in the ſea, than that he ſhould offend one of my little ones (U)."

He

(T) "Bleſſed are the merciful, for they ſhall obtain mercy," Matt. v. 7. "Forgive, and ye ſhall be forgiven; give, and it ſhall be given unto you," Luke vi. 37, 38. "Judge not, that ye be not judged; for with what judgement ye judge, ye ſhall be judged, and with what meaſure ye mete, it ſhall be meaſured to you again," Matt. vii. 2.

(U) Matt. xviii. 6. "But whoſo ſhall offend one of theſe little ones which believe in me, it were better for him that a millſtone were hanged about his neck, and that he were caſt into the ſea." The latter part of the paſſage

in

Scripture.

He aſcribes the firſt epiſtle to the Corinthians to Paul, and makes ſuch alluſions to the following books as are ſufficient to ſhew that he had ſeen and read them: Acts, Romans, 2 Corinthians, Galatians, Epheſians, Philippians, Coloſſians, 1 Theſſalonians, 1 Timothy, 2 Timothy, Titus, 1 Peter, 2 Peter.

It may be ſaid, as Clement has not mentioned the books by name from which we aſſert theſe alluſions or references are made, it is uncertain whether he refers to any books, or whether he received theſe expreſſions from the diſcourſes and converſation of the apoſtles. Mr Paley has given a very ſatisfactory anſwer to this objection: 1ſt, That Clement, in the very ſame manner, namely, without any mark of reference, uſes a paſſage now found in the epiſtle to the Romans *; which paſſage, from the peculiarity of the words that compoſe it, and from their order, it is manifeſt that he muſt have taken from the epiſtle. The ſame remark may be applied to ſome very ſingular ſentiments in the epiſtle to the Hebrews. Secondly, That there are many ſentences of St Paul's firſt epiſtle to the Corinthians, to be found in Clement's epiſtle, without any ſign of quotation, which yet certainly are quotations; becauſe it appears that Clement had St Paul's epiſtle before him; for in one place he mentions it in terms too expreſs to leave us in any doubt. "Take into your hands the epiſtle of the bleſſed apoſtle Paul." Thirdly, That this method of adopting words of ſcripture, without reference or acknowledgement, was a method in general uſe amongſt the moſt ancient Chriſtian writers. Theſe analogies not only repel the objection, but caſt the preſumption on the other ſide; and afford a conſiderable degree of poſitive proof, that the words in queſtion have been borrowed from the places of ſcripture in which we now find them. But take it, if you will, the other way, that Clement had heard theſe words from the apoſtles or firſt teachers of Chriſtianity; with reſpect to the preciſe point of our argument, viz. that the ſcriptures contain what the apoſtles taught, this ſuppoſition may ſerve almoſt as well.

* Chap. i. 29.

We have now traced the evidence to the times of the apoſtles; but we have not been anxious to draw it out to a great length, by introducing every thing. On the contrary, we have been careful to render it as conciſe as poſſible, that its force might be diſcerned at a glance. The evidence which has been ſtated is of two kinds. Till the time of Juſtin Martyr and Irenæus it conſiſts chiefly of alluſions, references, and expreſſions, borrowed from the books of the New Teſtament, without mentioning them by name. After the time of Irenæus it became uſual to cite the ſacred books, and mention the authors from whom the citations were taken.

106 The alluſions and references to the New Teſtament by the firſt Chriſtian writers prove that it exiſted in their time.

The firſt ſpecies of evidence will perhaps appear to ſome exceptionable; but it muſt be remembered that it was uſual among the ancient Chriſtians as well as Jews to adopt the expreſſions of Scripture without naming the authors. Why they did ſo it is not neceſſary to inquire. The only point of importance to be determined is, whether thoſe references are a ſufficient proof of the exiſtence of the books to which they allude? This, we preſume, will not be denied; eſpecially in the preſent age, when it is ſo common to charge an author with plagiariſm if he happen to fall upon the ſame train of ideas, or expreſs himſelf in a ſimilar manner with authors who have written before him. We may farther affirm, that theſe tacit references afford a complete proof that thoſe ancient writers had no intention of impoſing a forgery upon the world. They prove the exiſtence of the Chriſtian religion and of the apoſtolical writings, without ſhowing any ſuſpicious earneſtneſs that men ſhould believe them. Had theſe books been forged, thoſe who wiſhed to paſs them upon the world would have been at more pains than the firſt Chriſtians were to prove their authenticity. They acted the part of honeſt men; they believed them themſelves, and they never imagined that others would ſuſpect their truth.

It is a conſideration of great importance, in reviewing the evidence which has been now ſtated, that the witneſſes lived in different countries; Clemens flouriſhed at Rome, Polycarp at Smyrna, Juſtin Martyr in Syria, Irenæus in France, Tertullian at Carthage, Origen at Alexandria, and Euſebius at Cæſarea. This proves that the books of the New Teſtament were equally well known in diſtant countries by men who had no intercourſe with one another.

107 Teſtimonies of Heretics.

The ſame thing is proved by teſtimonies if poſſible leſs exceptionable. The ancient heretics, whoſe opinions were ſometimes groſſer and more impious than thoſe which any modern ſectary has ventured to broach, and whoſe zeal in the propagation of them equalled that of the moſt flaming enthuſiaſt of the laſt century, never called in queſtion the authenticity of the books of the New Teſtament. When they met with any paſſage in the goſpels or epiſtles which they could not reconcile to their own heretical notions, they either eraſed it, or denied that the author was inſpired; but they nowhere contend that the book in which it ſtood was not written by the apoſtle or evangeliſt whoſe name it bore. Euſebius relates, that the Ebionites rejected all the epiſtles of Paul, and called him an apoſtate, becauſe he departed from the Levitical law; and they adopted as their rule of faith the goſpel of St Matthew, though indeed they greatly corrupted it. This proves therefore that the goſpel according to Matthew was then publiſhed, and that St Paul's epiſtles were then known.

Of the heretics who eraſed or altered paſſages to make the Scriptures agree with their doctrines, we may produce Marcion as an inſtance, who lived in the beginning of the ſecond century. He lived in an age when he could have eaſily diſcovered if the writings of the New Teſtament had been forged; and as he was much incenſed againſt the orthodox party, if ſuch a forgery had been committed, unqueſtionably he would not have failed to make the diſcovery, as it would have afforded the moſt ample means of revenge and triumph, and enabled him to eſtabliſh his own opinions with leſs difficulty. But his whole conduct ſhows clearly, that he believed the writings of the New Teſtament to be authentic.

in Clement agrees more exactly with Luke xvii. 2. "It were better for him that a millſtone were hanged about his neck, and he caſt into the ſea, than that he ſhould offend one of theſe little ones."

Scripture. authentic. He ſaid, that the goſpel according to St Matthew, the epiſtle to the Hebrews, with thoſe of St Peter and St James, as well as the Old Teſtament in general, were writings not for Chriſtians but for Jews. He publiſhed a new edition of the goſpel according to Luke, and the firſt ten epiſtles of Paul; in which it has been affirmed by Epiphanius, that he altered every paſſage that contradicted his own opinions: but as many of theſe alterations are what modern critics call *various readings*, though we receive the teſtimony of Epiphanius, we muſt not rely upon his opinion (x). Hence it is evident that the books of the New Teſtament abovementioned did then exiſt, and were acknowledged to be the works of the authors whoſe names they bear.

Dr Lardner, in his General Review, ſums up this head of evidence in the following words: "Noetus, Paul of Samoſata, Sabellius, Marcellus, Photinus, the Novatians, Donatiſts, Manicheans (y), Priſcillianiſts, beſide Artemon, the Audians, the Arians, and divers others, all received moſt or all the ſame books of the New Teſtament which the Catholics received; and agreed in a like reſpect for them as writ by apoſtles or their diſciples and companions."

108
Teſtimonies of Heathens.

Celſus and Porphyry, both enemies of the Chriſtian religion, are powerful witneſſes for the antiquity of the New Teſtament. Celſus, who lived towards the end of the ſecond century, not only mentions by name, but quotes paſſages from the books of the New Teſtament: and that the books to which he refers were no other than our preſent goſpels, is evident from the alluſions to various paſſages ſtill found in them. Celſus takes notice of the genealogies, which fixes two of theſe goſpels; of the precepts, Reſiſt not him that injures you, and, If a man ſtrike thee on the one cheek, offer to him the other alſo; of the woes denounced by Chriſt; of his predictions; of his ſaying, that it is impoſſible to ſerve two maſters; of the purple robe, the crown of thorns, and the reed which was put into the hand of Jeſus; of the blood that flowed from his body upon the croſs, a circumſtance which is recorded only by John; and (what is *inſtar omnium* for the purpoſe for which we produce it) of the difference in the accounts given of the reſurrection by the evangeliſts, ſome mentioning two angels at the ſepulchre, others only one.

109
Of Celſus.

It is extremely material to remark, that Celſus not only perpetually referred to the accounts of Chriſt contained in the four goſpels, but that he referred to no other accounts; that he founded none of his objections to Chriſtianity on any thing delivered in ſpurious goſpels.

110
Of Porphyry.

The teſtimony of Porphyry is ſtill more important than that of Celſus. He was born in the year 213, of Tyrian origin. Unfortunately for the preſent age, ſays Michaelis, the miſtaken zeal of the Chriſtian emperors has baniſhed his writings from the world; and every real friend of our religion would gladly give the works of one of the pious fathers to reſcue thoſe of Porphyry from the flames. But Mr Marſh, the learned and judicious tranſlator of Michaelis, relates, that, according to the accounts of Iſaac Voſſius, a manuſcript of the works of Porphyry is preſerved in the Medicean library at Florence, but kept ſo ſecret that no one is permitted to ſee it. It is univerſally allowed, that Porphyry is the moſt ſenſible, as well as the moſt ſevere, adverſary of the Chriſtian religion that antiquity can produce. He was verſed not only in hiſtory, but alſo in philoſophy and politics. His acquaintance with the Chriſtians was not confined to a ſingle country; for he had converſed with them in Tyre, in Sicily, and in Rome. Enabled by his birth to ſtudy the Syriac as well as the Greek authors, he was of all the adverſaries to the Chriſtian religion the beſt qualified to inquire into the authenticity of the ſacred writings. He poſſeſſed therefore every advantage which natural abilities or a ſcientific education could afford to diſcover whether the New Teſtament was a genuine work of the apoſtles and evangeliſts, or whether it was impoſed upon the world after the deceaſe of its pretended authors. But no trace of this ſuſpicion is anywhere to be found in his writings. In the fragments which ſtill remain, mention is made of the goſpels of St Matthew, St Mark, and St John, the Acts of the Apoſtles, and the epiſtle to the Galatians; and it clearly appears from the very objections of Porphyry, that the books to which he alludes were the ſame which we poſſeſs at preſent. Thus he objects to the repetition of a generation in St Matthew's genealogy; to Matthew's call; to the quotation of a text from Iſaiah, which is found in a pſalm aſcribed to Aſaph; to the calling of the lake of Tiberias a ſea; to the expreſſion in St Matthew, "the abomination of deſolation;" to the variation in Matthew and Mark upon the text "the voice of one crying in the wilderneſs," Matthew citing it from Iſaias, Mark from the prophets; to John's application of the term *Word;* to Chriſt's change of intention about going up to the feaſt of tabernacles (John vii. 8.); to the judgement denounced by St Peter upon Ananias and Sapphira, which he calls an imprecation of death.

The inſtances here alleged ſerve in ſome meaſure to ſhow the nature of Porphyry's objections, and prove that Porphyry had read the goſpels with that ſort of attention which a writer would employ who regarded them as the depoſitaries of the religion which he attacked. Beſide theſe ſpecifications, there exiſts in the writings of ancient Chriſtians general evidence, that the places of Scripture, upon which Porphyry had made remarks, were very numerous.

111
Authenticity of the New Teſtament proved from internal evidence.

The internal evidence to prove the authenticity of the New Teſtament conſiſts of two parts: The nature of the ſtyle, and the coincidence of the New Teſtament with the hiſtory of the times.

112
From the ſtyle.

The ſtyle of the New Teſtament is ſingular, and differs very widely from the ſtyle of claſſical authors. It is full of Hebraiſms and Syriaſms; a circumſtance which pious ignorance has conſidered as a fault, and which, even ſo late as the preſent century, it has attempted to remove; not knowing that theſe very deviations from Grecian purity afford the ſtrongeſt preſumption in its favour: for they prove, *that the New Teſtament was written by men of Hebrew origin, and is therefore a production*

(x) Dr Loeffer has written a learned diſſertation to prove that Marcion did not corrupt the ſacred writings.

(y) This muſt be with an exception, however, of Fauſtus, who lived ſo late as the year 384.

Scripture. *duction of the firſt century.* After the death of the firſt Jewiſh converts, few of the Jews turned preachers of the goſpel; the Chriſtians were generally ignorant of Hebrew, and conſequently could not write in the ſtyle of the New Teſtament. After the deſtruction of Jeruſalem and the diſperſion of the Jews, their language muſt have been blended with that of other nations, and their vernacular phraſeology almoſt entirely loſt. The language of the early fathers, though not always the pureſt claſſic Greek, has no reſemblance to that of the New Teſtament, not even excepting the works of the few who had a knowledge of the Hebrew; as Origen, Epiphanius, and Juſtin Martyr, the laſt of whom being a native of Paleſtine, might have written in a ſtyle ſimilar to that of the New Teſtament, had ſuch a ſtyle then prevailed. He that ſuſpects the New Teſtament to be the forgery of a more recent period, ought to produce ſome perſon who has employed a ſimilar diction; but thoſe who are converſant with eaſtern writings know well that a foreigner, who has not been accuſtomed to eaſtern manners and modes of thinking from his infancy, can never imitate with ſucceſs the oriental ſtyle, much leſs forge a hiſtory or an epiſtle which contains a thouſand incidental alluſions, which nothing but truth could ſuggeſt. To imitate cloſely the ſtyle of the New Teſtament is even more difficult than to imitate that of any other oriental book; for there is not a ſingle author, even among the Jews themſelves, ſince the deſtruction of Jeruſalem, that has compoſed in a ſtyle in the leaſt degree like it (z).

But though the books of the New Teſtament bear ſo cloſe a reſemblance in idiom, there is a diverſity of ſtyle which ſhows them to be the work of different perſons. Whoever reads with attention the epiſtles of Paul, muſt be convinced that they were all written by the ſame author. An equal degree of ſimilarity is to be found between the goſpel and 1ſt epiſtle of John. The writings of St John and St Paul exhibit marks of an original genius which no imitation can ever attain. The character of Paul as a writer is drawn with great judgement by Michaelis: " His mind overflows with ſentiment, yet he never loſes ſight of his principal object, but hurried on by the rapidity of thought, diſcloſes frequently in the middle a concluſion to be made only at the end. To a profound knowledge of the Old Teſtament he joins the acuteneſs of philoſophical wiſdom, which he diſplays in applying and expounding the ſacred writings; and his explanations are therefore ſometimes ſo new and unexpected, that ſuperficial obſervers might be tempted to ſuppoſe them erroneous. The fire of his genius, and his inattention to ſtyle, occaſion frequently a twofold obſcurity, he being often too conciſe to be underſtood except by thoſe to whom he immediately wrote, and not ſeldom on the other hand ſo full of his ſubject, as to produce long and difficult parentheſes, and a repetition of the ſame word even in different ſenſes. With a talent for irony and ſatire, he unites the moſt refined ſenſibility, and tempers the ſeverity of his cenſures by expreſſions of tenderneſs and affection; nor does he ever forget in the vehemence of his zeal the rules of modeſty and decorum. He is a writer, in ſhort, of ſo ſingular and wonderful a compoſition, that it would be difficult to find a rival. That truly ſenſible and ſagacious philoſopher Locke was of the ſame opinion, and contended that St Paul was without an equal."

Poems have been forged and aſcribed to former ages with ſome ſucceſs. Philoſophical treatiſes might be invented which it would be difficult to detect; but there is not a ſingle inſtance on record where an attempt has been made to forge a hiſtory or a long epiſtle, where the fraud has not been either fully proved, or rendered ſo ſuſpicious that few are weak enough to believe it. Whoever attempts to forge a hiſtory or an epiſtle in the name of an ancient author, will be in great danger of contradicting the hiſtory or the manners of that age, eſpecially if he relate events which are not mentioned in general hiſtory, but ſuch as refer to a ſingle city, ſect, religion, or ſchool.

The difficulty of forging ſuch hiſtories as the goſpels, and ſuch epiſtles as thoſe of Paul, cannot be overcome by all the genius, learning, and induſtry, of any individual or ſociety of men that ever lived. They contain a purer ſyſtem of ethics than all the ancient philoſophers could invent: They diſcover a candour and modeſty unexampled: They exhibit an originality in the character of Jeſus, and yet ſuch a conſiſtency as the imagination of our beſt poets has never reached. Now it is a very remarkable circumſtance, that hiſtories written by four different men ſhould preſerve ſuch dignity and conſiſtency, though frequently relating different actions of Jeſus, and deſcending to the moſt minute circumſtances in his life. The ſcene of action is too extenſive, and the agreement of facts with the ſtate of the times as repreſented by other hiſtorians is too cloſe, to admit the poſſibility of forgery.

The ſcene of action is not confined to one country, it is ſucceſſively laid in the greateſt cities of the Roman empire; in Rome, in Antioch, in Corinth, in Athens, as well as in Jeruſalem and the land of Paleſtine. Innumerable alluſions are made to the manners and opinions of the Greeks, the Romans, and the Jews; and reſpecting the Jews, they extend even to the trifles and follies of their ſchools. Yet after the ſtricteſt examination, the New Teſtament will be found to have a wonderful coincidence and harmony with Joſephus, the principal hiſtorian of theſe times, and an enemy of Chriſtianity.

113
And from remarkable inſtances of coincidence between Joſephus and the New Teſtament.

It has been a queſtion who the ſoldiers were who are ſaid in the goſpel of Luke to have addreſſed John the Baptiſt in theſe words, *What ſhall we do?* An anſwer to this queſtion may be found in Joſephus *. Herod the tetrarch of Galilee was engaged in a war with his father-in-law Aretas, a petty king in Arabia Petræa, at the very time that John was preaching in the wilderneſs; and the road from Galilee to Arabia running through that wilderneſs, the ſoldiers on their march had this interview with the Baptiſt. A coincidence like this, which

* *Antiq.* lib. xviii. cap. 5. ſect. 1, 2.

(z) The ſtyle of Clemens Romanus may perhaps be an exception. By many eminent critics it has been thought ſo like to that of the epiſtle to the Hebrews, as to give room for the opinion that Clement either was the author of that epiſtle, or was the perſon who tranſlated it from the Syro-Chaldaic language, in which it was originally compoſed.

Scripture. which has been overlooked by all the commentators, would not probably be attended to in a forgery.

Chap. ii. § 11.

Another inſtance of an agreement no leſs remarkable we ſhall quote from the valuable work of Michaelis. It has been a queſtion of ſome difficulty among the learned, who was the Ananias who commanded St Paul to be ſmitten on the mouth when he was making his defence before the council in Jeruſalem *. Kreis, in his remarks taken from Joſephus, has ſhown him to have been the ſon of Nebedeni. But if ſo, how can it be reconciled with chronology, that Ananias was, at that time, called high prieſt, when it is certain from Joſephus that the time of his holding that office was much earlier? And how comes it to paſs that St Paul ſays, "I wiſt not, brethren, that he was the high prieſt?" The ſacerdotal garb muſt have diſcovered who he was: a jeſt would have ill-ſuited the gravity of a tribunal; and a falſehood is inconſiſtent with the character of St Paul.

* Acts xxiii. 2—5.

All theſe difficulties vaniſh as ſoon as we examine the ſpecial hiſtory of that period: "Ananias the ſon of Nebedeni was high prieſt at the time that Helena queen of Adiabene ſupplied the Jews with corn from Egypt during the famine which took place in the fourth year of Claudius, mentioned in the eleventh chapter of the Acts. St Paul therefore, who took a journey to Jeruſalem at that period, could not have been ignorant of the elevation of Ananias to that dignity. Soon after the holding of the firſt council, as it is called, at Jeruſalem, Ananias was diſpoſſeſſed of his office, in conſequence of certain acts of violence between the Samaritans and the Jews, and ſent priſoner to Rome; but being afterwards releaſed, he returned to Jeruſalem. Now from that period he could not be called *high-prieſt* in the proper ſenſe of the word, though Joſephus has ſometimes given him the title of ἀρχιερευς, taken in the more extenſive meaning of a prieſt who had a ſeat and voice in the Sanhedrim; and Jonathan, though we are not acquainted with the circumſtances of his elevation, had been raiſed in the mean time to the ſupreme dignity in the Jewiſh church. Between the death of Jonathan, who was murdered by order of Felix, and the high-prieſthood of Iſmael, who was inveſted with that dignity by Agrippa, elapſed an interval during which the ſacerdotal office was vacant. Now it happened preciſely in this interval that St Paul was apprehended in Jeruſalem: and, the Sanhedrim being deſtitute of a preſident, he undertook of his own authority the diſcharge of that office, which he executed with the greateſt tyranny. It is poſſible therefore that St Paul, who had been only a few days in Jeruſalem, might be ignorant that Ananias, who had been diſpoſſeſſed of the prieſthood, had taken upon himſelf a truſt to which he was not entitled; he might therefore very naturally exclaim, 'I wiſt not, brethren, that he was the high-prieſt!' Admitting him on the other hand to have been acquainted with the fact, the expreſſion muſt be conſidered as an indirect reproof, and a tacit refuſal to recognize uſurped authority."

Could ſuch a correſpondence as this ſubſiſt between truth and falſehood, between a forgery and an authentic hiſtory? or is it credible that theſe events could be related by any perſon but a contemporary?

Impreſſed with the love of truth, and feeling contempt as well as deteſtation at pious frauds, we heſitate not to acknowledge, that in ſome particular facts there is a difference either real or apparent between Joſephus and the writers of the New Teſtament. The objections ariſing from theſe differences are of two kinds: 1. Such as would prove a book not to have been written by the author to whom it is aſcribed. 2. Such as would prove that the author was miſtaken, and therefore not divinely inſpired. To the firſt claſs belongs the following objection: St Paul ſays (2 Cor. xi. 32.) that the governor of Damaſcus was under Aretas the king: but if we are to judge from the 18th book of the Jewiſh Antiquities, which correſponds with the period of St Paul's journey to Damaſcus, that city muſt have belonged at that time to the Romans; and what authority could Aretas, a petty king in Arabia Petræa, have in ſuch a city? In anſwer to this queſtion, J. G. Hyne, in a diſſertation publiſhed in 1755, has ſhown it to be highly probable that Aretas, againſt whom the Romans, not long before the death of Tiberius, made a declaration of war, which they neglected to put in execution, took the opportunity of ſeizing Damaſcus, which had once belonged to his anceſtors; an event omitted by Joſephus, as forming no part of the Jewiſh hiſtory, and by the Roman hiſtorians as being a matter not flattering in itſelf, and belonging only to a diſtant province. Secondly, That Aretas was by religion a Jew; a circumſtance the more credible, when we reflect that Judaiſm had been widely propagated in that country, and that even kings in Arabia Felix had recognized the law of Moſes. The difficulty then is ſo far removed, that it ceaſes to create ſuſpicion againſt an epiſtle which has ſo many evident marks of authenticity; and it is only to be regretted that, in order to place the ſubject in the cleareſt point of view, we are not ſufficiently acquainted with the particular hiſtory of Damaſcus.

114 There are alſo apparent inconſiſtencies, but theſe probably ariſe from overſight in Joſephus;

Examples of the ſecond kind are ſuch as, if allowed their full force, might indeed prove a writer not divinely inſpired, but could afford no reaſon to conclude that he was not the author of the writings which bear his name, ſince miſtakes may be committed by the moſt accurate hiſtorian. The chief difficulties of this nature are found in the goſpel according to St Luke, and do not apply to the writings of Matthew, John, Paul, and Peter. Laying aſide the idea of inſpiration altogether, let us inquire whether Luke or Joſephus be moſt intitled to credit in thoſe paſſages where they differ; which of them is moſt accurate, and which of them had the beſt opportunities of exploring the truth of the facts which they relate. Now Joſephus relates the ſame ſtory differently in different parts of his works, and is ſometimes equally miſtaken in them all. We do not recollect to have ſeen ſuch inconſiſtencies in the writings of St Luke. Luke knew the characters, and witneſſed many of the facts, of which he ſpeaks; and he could receive the beſt information reſpecting thoſe facts which were tranſacted in his abſence. Joſephus was born A. D. 37, ſome years after our Saviour's aſcenſion. Now it is a very important obſervation of Michaelis, that the period of hiſtory with which mankind are leaſt acquainted is that which includes the time of their childhood and youth, together with the twenty or thirty years immediately preceding their birth. Concerning the affairs tranſacted during that period, we are much more liable to fall into miſtakes than concerning thoſe

115 or to his want of authentic information concerning the events that happened near his birth.

thoſe of a remoter age. The reaſon is, that authentic hiſtory never comes down to the period of our birth; our knowledge of the period immediately preceding depends on hearſay; and the events, which paſs within the firſt eighteen or twenty years of our lives, we are too young and heedleſs to obſerve with attention. This muſt have been more remarkably the caſe in the time of Joſephus than at preſent, when there were neither daily papers nor periodical journals to ſupply the want of regular annals. There was no hiſtorian from whom Joſephus could derive any knowledge of the times that immediately preceded his birth. There is a period then of forty or fifty years, in which, even with the moſt diligent inquiry, he was expoſed to error.

When we find therefore the relations of Luke and Joſephus ſo different as not to be reconciled, it would be very unfair to determine without any further inquiry in favour of Joſephus. Let their character, and works, and ſituation, be ſtrictly examined; let their teſtimony be duly weighed and compared; and then let the preference be given to that author who, according to the ſtricteſt rules of equity and juſtice, ſeems intitled to the higheſt degree of credit. The deciſion of a jury, we ſhall venture to ſay, would in every inſtance turn out in favour of Luke.

116 Inſpiration of the New Teſtament.

Having thus aſcertained the authenticity of the books of the New Teſtament, the next thing to be conſidered is their inſpiration. It is certainly of ſome importance to know how far the apoſtles and evangeliſts were guided in their writings by the immediate influence of the ſpirit of God; though this knowledge, if attainable, is not equally important with that of the authenticity of theſe writings. Michaelis indeed aſſerts, that the divinity of the New Teſtament may be proved whether we can evince it to be written by immediate inſpiration or not *. "The queſtion (ſays he), whether the books of the New Teſtament are inſpired? is not ſo important as the queſtion, whether they are genuine? The truth of our religion depends upon the latter, not abſolutely on the former. Had the Deity inſpired not a ſingle book of the New Teſtament, but left the apoſtles and evangeliſts without any other aid than that of natural abilities to commit what they knew to writing, admitting their works to be authentic, and poſſeſſed of a ſufficient degree of credibility, the Chriſtian religion would ſtill be well founded. The miracles by which it is confirmed would equally demonſtrate its truth, even if the perſons who atteſted them were not inſpired, but ſimply human witneſſes; and their divine authority is never preſuppoſed, when we diſcuſs the queſtion of miracles, but merely their credibility as human evidence. If the miracles are true which the evangeliſts relate, the doctrines of Chriſt recorded in the goſpels are proved to be the infallible oracles of God; and, even if we admit the apoſtles to be miſtaken in certain not eſſential circumſtances, yet as the main points of the religion which Chriſt commiſſioned them to preach are ſo frequently repeated, their epiſtles would inſtruct us as well in the tenets of the Chriſtian ſyſtem, as the works of Maclaurin in the philoſophy of Newton. It is poſſible therefore to doubt, and even deny, the inſpiration of the New Teſtament, and yet be fully perſuaded of the truth of the Chriſtian religion: and many really entertain theſe ſentiments either publicly or in private, to whom we

* Chap. iii. § 1.

117 [not neceſſary to the truth of Chriſtianity according to the opinion of Michaelis.]

ſhould render great injuſtice, if we ranked them in the claſs of unbelievers.

"Yet the Chriſtian religion would be attended with difficulty, if our *principium cognoſcendi* reſted not on firmer ground; and it might be objected, that ſufficient care had not been taken for thoſe whoſe conſciences were tender, and who were anxiouſly fearful of miſtaking the ſmalleſt of the divine commands. The chief articles indeed of Chriſtianity are ſo frequently repeated, both by Chriſt and his apoſtles, that even were the New Teſtament not inſpired, we could entertain no doubt of the following doctrines: 'Jeſus was the Meſſias of the Jews, and an infallible meſſenger of God: he died for our iniquity; and by the ſatisfaction made by his death we obtain remiſſion of ſins, if on our part be faith and amendment of life: the Levitical law is aboliſhed, and moral precepts, with the ceremonies of Baptiſm and the Supper of the Lord, are appointed in its ſtead; after the preſent follows an everlaſting life, in which the virtuous ſhall be rewarded and the wicked puniſhed, and where Chriſt himſelf ſhall be the Judge.'

"To the epiſtles indeed (ſays Michaelis), inſpiration is of real conſequence; but with reſpect to the hiſtorical books, viz. the Goſpels and the Acts of the Apoſtles, we ſhould really be no loſers if we abandoned the ſyſtem of inſpiration, and in ſome reſpects have a real advantage. We ſhould be no loſers, if we conſidered the apoſtles in hiſtorical facts as merely human witneſſes, as Chriſt himſelf has done in ſaying, 'Ye alſo ſhall bear witneſs, becauſe ye have been with me from the beginning *.' And no one that attempts to convince an unbeliever of the truth of Chriſtianity, would begin his demonſtration by preſuppoſing a doctrine which his adverſary denies, but would ground his arguments on the credibility of the evangeliſts as human hiſtorians, for the truth of the miracles, the death, and the reſurrection of Chriſt. Even thoſe who examine the grounds of their faith for their own private conviction, muſt treat the evangeliſts as human evidence; ſince it would be arguing in a circle to conclude that the facts recorded in the goſpels are true, becauſe they are inſpired, when we conclude the Scriptures to be inſpired in conſequence of their contents. In theſe caſes, then, we are obliged to conſider the evangeliſts as human evidence; and it would be no detriment to the Chriſtian cauſe to conſider them at all times as ſuch in matters of hiſtorical fact. We find it nowhere expreſsly recorded that the public tranſactions which the apoſtles knew by their own experience, and of which St Luke informed himſelf by diligent inquiry, ſhould be particular objects of divine inſpiration. We ſhould even be conſiderable gainers, in adjuſting the harmony of the goſpels, if we were permitted to ſuppoſe that ſome one of the evangeliſts had committed an immaterial error, and that St John has rectified ſome trifling miſtakes in the preceding goſpels. The moſt dangerous objections which can be made to the truth of our religion, and ſuch as are moſt difficult to anſwer, are thoſe drawn from the different relations of the four evangeliſts."

* John xv. 27.

118 Different meanings of the word inſpiration.

Before any inquiry is made reſpecting the inſpiration of the books of the New Teſtament, it is neceſſary to determine the meaning of the term; for theologians have given to it a variety of ſignifications. Moſt of the German divines make it to conſiſt in an infuſion of words as well as ideas. Luther, Beza, and Salmaſius, reſtrict it to ideas alone. Doddridge underſtands by it an intervention of the Deity, by which the natural faculties of the mind were directed to the diſcovery of truth. Warburton and Law think it was a negative intervention to preſerve the ſacred writers from eſſential errors. Some believe every circumſtance was dictated by the Holy Ghoſt; others ſuppoſe that no ſupernatural aſſiſtance was granted except in the epiſtolary writings. See INSPIRATION.

As there is an evident diſtinction between inſpiration and revelation, and as the origin of the Chriſtian religion may be ſtill proved divine, even though it were denied that thoſe who record its facts and doctrines were inſpired in the act of writing, it will be moſt judicious and ſafe to employ the word *inſpiration* in that ſenſe which can be moſt eaſily defended and ſupported. By doing this, much may be gained and nothing loſt. It is difficult to prove to a deiſt that the words of Scripture are divine, becauſe he ſees that every writer has words and phraſes peculiar to himſelf. It is difficult alſo to prove that the ideas were infuſed into the mind of the authors while they were engaged in the act of writing; becauſe concerning facts they appeal not to divine inſpiration, but declare *what they have ſeen and heard*. In reaſoning they add their own ſentiments to what they had received from the Lord, and ſubjoin, eſpecially in their epiſtles, things not connected with religion. The definition which Doddridge gives, ſeems applicable to ordinary gifts or the uſual endowments of rational creatures, rather than to the extraordinary gifts of the Holy Spirit, which were beſtowed on the apoſtles. Thoſe who maintain that every fact or circumſtance was ſuggeſted by divine inſpiration, will find it no eaſy matter to prove their poſition. The opinion of Warburton and Law, with proper explanations, ſeems moſt probable. The opinion of Grotius, that only the epiſtles were inſpired, may be eaſily refuted.

The proof of the authenticity of the New Teſtament depends on human teſtimony: The proof of its inſpiration is derived from the declaration of inſpired perſons.

119
The proof of it depends on the declarations of Chriſt and his apoſtles.

In proving that the New Teſtament is inſpired, we preſuppoſe its authenticity, that the ſacred books were written by the apoſtles whoſe names they bear, and that they have been conveyed to us pure and uncorrupted. This we have already attempted to prove, and we hope with ſucceſs. The evidence of inſpiration is the teſtimony of Chriſt and his apoſtles, which we receive as credible, becauſe they confirmed their doctrines by miracles. From the important miſſion of Chriſt and his apoſtles, we infer that every power was beſtowed which divine wiſdom thought expedient; and from their conduct we conclude, that it is morally impoſſible that they could lay claim to any powers which they did not poſſeſs. It is proper therefore to inquire into the declarations of Chriſt and his apoſtles concerning the nature, degree, and extent, of the inſpiration beſtowed on the writers of the ſacred books.

120
The declarations of Chriſt.

If we conſider Chriſt's more immediate promiſes of inſpiration to the apoſtles, we ſhall find that he has given them, in the moſt proper ſenſe of the word, at three ſeveral periods, 1ſt, When he ſent the apoſtles to preach the goſpel *; 2dly, In holding a public diſcourſe relating to the goſpel, at which were preſent a conſiderable multitude; 3dly, In his prophecy of the deſtruction of Jeruſalem †. When he ſent the apoſtles to preach the goſpel, he thus addreſſed them: "When they deliver you up, take no thought how or what ye ſhall ſpeak, for it ſhall be given you in that ſame hour what ye ſhall ſpeak; for it is not you that ſpeak, but the ſpirit of your father that ſpeaketh in you." The ſame promiſe was made almoſt in the ſame words in the preſence of an immenſe multitude (Luke xii. 11, 12.). From theſe paſſages it has been urged, that if the apoſtles were to be inſpired in the preſence of magiſtrates in delivering ſpeeches, which were ſoon to be forgotten, it is ſurely reaſonable to conclude that they would be inſpired when they were to compoſe a ſtandard of faith for the uſe of all future generations of Chriſtians. If this concluſion be fairly deduced, it would follow that the writings of the New Teſtament are the dictates of inſpiration, not only in the doctrines and precepts, but in the very words. But it is a concluſion to which ſincere Chriſtians have made objections; for, ſay they, though Chriſt promiſes to aſſiſt his apoſtles in caſes of great emergency, where their own prudence and fortitude could not be ſufficient, it does not follow that he would dictate to them thoſe facts which they knew already, or thoſe reaſonings which their own calm reflection might ſupply. Beſides, ſay they, if the New Teſtament was dictated by the Holy Spirit, and only penned by the apoſtles, what reaſon can be given for the care with which Chriſt inſtructed them both during his miniſtry and after his crucifixion in thoſe things pertaining to the kingdom of God?

* Matt. x. 19, 20.

† Mark xiii. 11.; Luke xxi. 14, 15.

121
Proper idea of inſpiration.

In anſwer to this, we may obſerve, that though it be difficult to prove that the identical words of the New Teſtament were dictated by the Holy Spirit, or the train of ideas infuſed into the minds of the ſacred writers, there is one ſpecies of inſpiration to which the New Teſtament has an undoubted claim. It is this, that the memories of the apoſtles were ſtrengthened and their underſtandings preſerved from falling into eſſential errors. This we prove from theſe words of our Saviour, "and I will pray the Father, and he will give you another comforter, that he may abide with you for ever. He ſhall teach you all things, and bring all things to your remembrance whatſoever I have ſaid unto you *." This promiſe was ſurely not reſtrained to the day of Pentecoſt: it muſt have been a permanent gift, enabling the apoſtles at all times to remember with accuracy the diſcourſes of our Saviour. When the apoſtles therefore (Matthew and John) relate thoſe precepts of Chriſt which they themſelves had heard, they write indeed from memory, but under the protection of the ſpirit who ſecures them from the danger of miſtake: and we muſt of courſe conclude that their goſpels are inſpired.

* John xiv. 16, 26.

Were we called upon more particularly to declare what parts of the New Teſtament we believe to be inſpired, we would anſwer, The doctrines, the precepts, and the prophecies, every thing eſſential to the Chriſtian religion. From theſe the idea of inſpiration is inſeparable. As to the events, the memory of the apoſtles was ſufficient to retain them. If this opinion be juſt, it would enable us to account for the diſcrepancies between the ſacred writers, which are chiefly confined to the relation of facts and events.

All the books of the New Teſtament were originally written in Greek, except the Goſpel according to Matthew

thew and the epiſtle to the Hebrews, which there is reaſon to believe were compoſed in the Syro-Chaldaic language, which in the New Teſtament is called Hebrew.

122 Language in which the New Teſtament was compoſed.

123 Why the greateſt part of it is written in Greek.

Various reaſons have been aſſigned why the greateſt part of the New Teſtament was written in Greek; but the true reaſon is this, It was the language beſt underſtood both by writers and readers. Had St Paul written to a community in the Roman province of Africa, he might have written perhaps in Latin; but epiſtles to the inhabitants of Corinth, Galatia, Epheſus, Philippi, and Theſſalonica, to Timothy, Titus, and Philemon, from a native of Tarſus, could hardly be expected in any other language than Greek. The ſame may be ſaid of the epiſtles of St Peter, which are addreſſed to the Chriſtians of different countries, who had no other language in common than the Greek; and likewiſe of the epiſtles of St James, who wrote to Jews, that lived at a diſtance from Paleſtine, and were ignorant of Hebrew. The native language of St Luke, as well as of Theophilus, to whom he addreſſed his goſpel, and Acts of the apoſtles, appears to have been Greek; and that St John wrote his goſpel in that language, and not in Hebrew, is by no means a matter of ſurpriſe, ſince he wrote at Epheſus.

Michaelis, vol. i. chap. iv. ſect. 1. p. 101.

With reſpect to the epiſtle to the Romans, it may be aſked indeed why St Paul did not write in Latin? Now, whoever propoſes this queſtion, muſt preſuppoſe that St Paul was maſter of the Latin language in ſuch a degree as to find no difficulty in writing it; a matter which remains to be proved. It is very probable that St Paul was acquainted with the Latin; but between underſtanding a language, and being able to write it, there is a very material difference. As St Paul was a native of Tarſus, his native language was Greek; he had travelled during ſeveral years through countries in which no other language was ſpoken, and when he addreſſed the Roman centurion at Jeruſalem, he ſpoke not Latin, but Greek. Is it extraordinary, then, that in writing to the inhabitants of Rome he ſhould have uſed a language which was there ſo generally underſtood? It has been long remarked, that Greek was at that time as well known in Rome as French in any court of modern Europe; that according to Juvenal even the female ſex made uſe of Greek as the language of familiarity and paſſion; and that in letters of friendſhip Greek words and phraſes were introduced with greater freedom than French expreſſions in German letters, as appears from Cicero's epiſtles to Atticus, and from thoſe of Auguſtus preſerved in the works of Suetonius. To this muſt be added a material circumſtance, that a great part of the Roman Chriſtians conſiſted of native Jews, who were better acquainted with Greek than with Latin, as either they themſelves or their anceſtors had come from Greece, Aſia Minor, or Egypt, in which Greek was the language of the country. At leaſt they read the Bible in that language, as no Latin tranſlation of the Old Teſtament at that time exiſted; and the Chriſtian church at that period conſiſting chiefly of Jews, the heathen converts in Rome were of courſe under the neceſſity of accuſtoming themſelves to the Greek language. In ſhort, St Paul in his epiſtle to the Romans made uſe of a language in which alone thoſe who were ignorant of Hebrew could read the Bible. What has been here advanced reſpecting the epiſtle to the Romans is equally applicable to the Greek of St Mark, on the ſuppoſition that it was written at Rome.

To the above arguments may be added the example of Joſephus, who, as well as the apoſtles, was by birth a Jew. He even lived in Rome, which is more than can be ſaid of St Paul and St Mark, who reſided there only a certain time: he was likewiſe younger than either; he came to Italy at an age which is highly ſuitable to the learning of a language, and previous to that period had ſpent ſeveral years in the Roman camp. The Jewiſh antiquities, the hiſtory of the Jewiſh war, and the account of his own life, he wrote undoubtedly with a view of their being read by the Romans; and yet he compoſed all theſe writings in Greek. He expreſſes his motive for writing his Greek account of the Jewiſh war in the following terms: "That having written in his native language (i. e. the Hebrew dialect at that time ſpoken) a hiſtory of the war, in order that Parthians, Babylonians, Arabians, Adiabenes, and the Jews beyond the Euphrates, might be informed of thoſe events, he was now reſolved to write for the Greeks and Romans, who had not been engaged in the campaigns, a more certain account than had hitherto been given." The motives which induced Joſephus to write in Greek are fully as applicable to St Paul and St Mark.

Michaelis, vol. i. chap. iv. ſect. 3. p. 1. 1.

124 Is full of Hebraiſms.

Michaelis has thus characterized the ſtyle of the New Teſtament. "The New Teſtament (ſays he) was written in a language at that time common among the Jews, which may be named Hebraic Greek; the firſt traces of which we find in the tranſlation of the LXX.

"Every man acquainted with the Greek language, who had never heard of the New Teſtament, muſt immediately perceive, on reading only a few lines, that the ſtyle is widely different from that of the claſſic authors. We find this character in all the books of the New Teſtament in a greater or leſs degree, but we muſt not therefore conclude that they poſſeſs an uniformity of ſtyle. The harſheſt Hebraiſms, which extended even to grammatical errors in the government of caſes, are the diſtinguiſhing marks of the book of Revelation; but they are accompanied with tokens of genius and poetical enthuſiaſm of which every reader muſt be ſenſible who has taſte and feeling. There is no tranſlation of it which is not read with pleaſure even in the days of childhood; and the very faults of grammar are ſo happily placed as to produce an agreeable effect. The goſpels of St Matthew and St Mark have ſtrong marks of this Hebraic ſtyle; the former has harſher Hebraiſms than the latter, the fault of which may be aſcribed to the Greek tranſlator, who has made too literal a verſion, and yet the goſpel of St Mark is written in worſe language, and in a manner that is leſs agreeable. The epiſtles of St James and St Jude are ſomewhat better; but even theſe are full of Hebraiſms, and betray in other reſpects a certain Hebrew tone. St Luke has in ſeveral paſſages written pure and claſſic Greek, of which the firſt four verſes of his goſpel may be given as an inſtance: in the ſequel, where he deſcribes the actions of Chriſt, he has very harſh Hebraiſms, yet the ſtyle is more agreeable than that of St Matthew or St Mark. In the Acts of the apoſtles he is not free from Hebraiſms, which he ſeems to have never ſtudiouſly avoided; but his periods are more claſſically turned, and ſometimes poſſeſs beauty

Scripture. beauty devoid of art. St John has numerous, though not uncouth, Hebraiſms both in his goſpel and epiſtles; but he has written in a ſmooth and flowing language, and ſurpaſſes all the Jewiſh writers in the excellence of narrative. St Paul again is entirely different from them all; his ſtyle is indeed neglected and full of Hebraiſms, but he has avoided the conciſe and verſe-like conſtruction of the Hebrew language, and has upon the whole a conſiderable ſhare of the roundneſs of Grecian compoſition. It is evident that he was as perfectly acquainted with the Greek manner of expreſſion as with the Hebrew, and he has introduced them alternately, as either the one or the other ſuggeſted itſelf the firſt, or was the beſt approved."

125 and foreign idioms.

Michaelis has ſhown that the New Teſtament not only contains Hebraiſms but Rabbiniſms, Syriaſms, Chaldaiſms, Arabiſms, Latiniſms, and Perſian words, of which he has exhibited many ſpecimens. To theologians, whoſe duty it certainly is to ſtudy the language of the New Teſtament with attention, we would ſtrenuouſly recommend the peruſal of this work, which in the Engliſh tranſlation is one of the moſt valuable acceſſions to ſcriptural criticiſm that has yet appeared. We ſpeak of the Engliſh tranſlation, which the large and judicious notes of Mr Marſh has rendered infinitely ſuperior to the original.

126 Peculiarities in the compoſition. *Dr Campbell's Preliminary Diſſertations to his Tranſlations of the Goſpels.*

To the obſervations which have been made reſpecting the language of the New Teſtament, a few remarks may be added concerning the peculiarities of the ſtyle and manner of the ſacred writers, particularly the hiſtorians. Theſe remarks extend to the Old Teſtament as well as to the New.—The *firſt* quality for which the ſacred hiſtory is remarkable is ſimplicity in the ſtructure of the ſentences. The firſt five verſes of Geneſis furniſh an example, which conſiſt of eleven ſentences. The ſubſtantives are not attended by adjectives, nor the verbs by adverbs, no ſynonymas, no ſuperlatives, no effort at expreſſing things in a bold, emphatical, or uncommon manner.

2. The ſecond quality is ſimplicity of ſentiment, particularly in the Pentateuch, ariſing from the very nature of the early and uncultivated ſtate of ſociety about which that book is converſant.

3. Simplicity of deſign. The ſubject of the narrative ſo engroſſes the attention of the writer, that he himſelf is as nobody. He introduces nothing as from himſelf, no remarks, doubts, conjectures, or reaſonings. Our Lord's biographers particularly excel in this quality. This quality of ſtyle we meet with in Xenophon and Cæſar.

The Evangeliſts may be ranked next to Geneſis for ſimplicity of compoſition in the ſentences. John and Matthew are diſtinguiſhed for it more than Mark and Luke. But the ſentiment is not ſo remarkable for ſimplicity in the Evangeliſt as the Pentateuch. The reaſons of this difference are, the ſtate of the Jews was totally changed; their manners, cuſtoms, &c. ſplit into factions both in religion and politics. 2. The object of our Lord's miniſtry, which is the great ſubject of the goſpels, was *to inculcate a doctrine and morality* with which none of their ſyſtems perfectly coincided: beſides, being conſtantly oppoſed by all the great men, the greater part of his hiſtory conſiſts of inſtructions and diſputes. 3. As it is occupied with what our Saviour ſaid and what he did, this makes two diſtinctions of ſtyle and manner; that of our Saviour, and the ſacred penman's. In their own character, they neither explain nor command, promiſe nor threaten, praiſe nor blame. They generally omit the names of our Lord's enemies; thus directing our hatred at the vices they committed, not at the perſons. They never mention ſuch perſons without neceſſity; which is the caſe with the high-prieſt, Pilate, Herod, and Judas: the three firſt for the chronology, the fourth to do juſtice to the eleven.

Herodias is indeed mentioned with diſhonour; but her crime was a public one. On the other hand, all perſons diſtinguiſhed for any thing virtuous are carefully mentioned, Joſeph of Arimathea, Nicodemus, Zaccheus, Bartimeus, Jairus, Lazarus, Mary, and Martha. They record their own faults (Peter's, Thomas's), nor do they make any merit of their confeſſion. In one uniform ſtrain they relate the moſt ſignal miracles and moſt ordinary facts.

From the narrative is excluded that quality of ſtyle which is called *animation*. Nothing that diſcovers paſſion in the writer or is calculated to excite the paſſions of the reader. Every thing is directed to mend the heart.

But in the diſcourſes and dialogues of our Saviour the expreſſion, without loſing any thing of its ſimplicity, is often remarkable for ſpirit and energy. Reſpecting harmony and ſmoothneſs, qualities which only add an external poliſh to language, they had not the leaſt ſolicitude.

As to elegance, there is an elegance which reſults from the uſe of ſuch words as are moſt in uſe with thoſe who are accounted fine writers, and from ſuch arrangements in the words and clauſes as have generally obtained their approbation. This is diſclaimed by the ſacred authors.

But there is an elegance of a ſuperior order more nearly connected with the ſentiment; and in this ſort of elegance they are not deficient. In all the oriental languages great uſe is made of tropes, eſpecially metaphors. When the metaphors employed bear a ſtrong reſemblance, they confer vivacity: if they be borrowed from objects which are naturally agreeable, beautiful, or attractive, they add alſo elegance. The Evangeliſts furniſh us with many examples of this kind of vivacity and elegance. Our Lord borrows tropes from cornfields, vineyards, gardens, &c.

127 Proper method of ſtudying the New Teſtament by analyſis and induction.

As a valuable appendage to this part of our ſubject, we ſhall ſubjoin Dr Campbell's method of ſtudying the books of the New Teſtament. This we offer to our readers as a beautiful inſtance of the judicious application of philoſophy to ſacred ſtudies. It is the ſame method of diſcovering truth by analyſis and induction, which was purſued by Sir Iſaac Newton with ſuch aſtoniſhing ſucceſs, which ſince his time has been uniformly practiſed in natural philoſophy, and has been alſo applied to chemiſtry, to medicine, to natural hiſtory, and to the philoſophy of mind, by the ingenious Dr Reid. This is the path of ſound philoſophy, which can alone lead to the diſcovery of truth. In following it, our progreſs may be ſlow, but it will be ſure. If all theologians would ſteadily adhere to it, we might then entertain the pleaſing hope of diſcarding for ever thoſe abſurd ſyſtems of religion which are founded on ſingle paſſages and detached fragments of ſcripture, and of eſtabliſhing opinions and doctrines on a ſolid foundation.

"1. To

128 Dr Campbell's method. *Prel. Diſ. to the Goſpels.*

" 1. To get acquainted with each writer's ſtyle; to obſerve his manner of compoſition, both in ſentences and paragraphs; to remark the words and phraſes peculiar to him, and the peculiar application that he may ſometimes make of ordinary words; for there are few of thoſe writers who have not their peculiarities in all the reſpects now mentioned. This acquaintance with each can be attained only by the frequent and attentive reading of his works in his own language.

" 2. To inquire into the character, the ſituation, and the office of the writer, the time, the place, and the occaſion of his writing, and the people for whoſe immediate uſe he originally intended his work. Every one of theſe particulars will ſometimes ſerve to elucidate expreſſions otherwiſe obſcure or doubtful. This knowledge may in part be learned from a diligent and reiterated peruſal of the book itſelf, and in part be gathered from what authentic, or at leaſt probable, accounts have been tranſmitted to us concerning the compilement of the canon.

" 3. The laſt general direction is, to conſider the principal ſcope of the book, and the particulars chiefly obſervable in the method by which the writer has purpoſed to execute his deſign. This direction is particularly applicable to the epiſtolary writings, eſpecially thoſe of Paul.

" 4. If a particular word or phraſe occur, which appears obſcure, perhaps unintelligible, the firſt thing we ought to do, if ſatisfied that the reading is genuine, is to conſult the context, to attend to the manner wherein the term is introduced, whether in a chain of reaſoning or in a hiſtorical narration, in a deſcription, or included in an exhortation or command. As the concluſion is inferred from the premiſſes, or as from two or more known truths a third unknown or unobſerved before may fairly be deduced; ſo from ſuch attention to the ſentence in connection, the import of an expreſſion, in itſelf obſcure or ambiguous, will ſometimes with moral certainty be diſcovered. This, however, will not always anſwer.

" 5. If it do not, let the ſecond conſideration be, whether the term or phraſe be one of the writer's peculiarities. If ſo, it comes naturally to be inquired, what is the acceptation in which he employs it in other places? If the ſenſe cannot be preciſely the ſame in the paſſage under review, perhaps, by an eaſy and natural metaphor or other trope, the common acceptation may give riſe to one which perfectly ſuits the paſſage in queſtion.—Recourſe to the other places wherein the word or phraſe occurs in the ſame author is of conſiderable uſe, though the term ſhould not be peculiar to him.

" 6. But thirdly, if there ſhould be nothing in the ſame writer that can enlighten the place, let recourſe be had to the parallel paſſages, if there be any ſuch, in the other ſacred writers. By parallel paſſages, I mean thoſe places, if the difficulty occur in hiſtory, wherein the ſame or a ſimilar ſtory, miracle, or event, is related; if in teaching or reaſoning, thoſe parts wherein the ſame argument or doctrine is treated, or the ſame parable propounded; and in moral leſſons, thoſe wherein the ſame claſs of duties is recommended; or, if the difficulty be found in a quotation from the Old Teſtament, let the parallel paſſage in the book referred to, both in the original Hebrew, and in the Greek verſion, be conſulted.

" 7. But if in theſe there be found nothing that can throw light on the expreſſion of which we are in doubt, the fourth recourſe is to all the places wherein the word or phraſe occurs in the New Teſtament, and in the Septuagint verſion of the Old, adding to theſe the conſideration of the import of the Hebrew or Chaldaic word, whoſe place it occupies, and the extent of ſignification, of which in different occurrences ſuch Hebrew or Chaldaic term is ſuſceptible.

" 8. Perhaps the term in queſtion is one of thoſe which very rarely occur in the New Teſtament, or thoſe called ἁπαξ λεγομενα, only once read in Scripture, and not found at all in the tranſlation of the Seventy. Several ſuch words there are. There is then a neceſſity, in the fifth place, for recurring to the ordinary acceptation of the term in claſſical authors. This is one of thoſe caſes wherein the interpretation given by the earlieſt Greek fathers deſerves particular notice. In this, however, I limit myſelf to thoſe comments wherein they give a literal expoſition of the ſacred text, and do not run into viſion and allegory.

129 Manuſcripts of the New Teſtament.

The manuſcripts of the New Teſtament are the natural ſource from which the genuine readings of the Greek Teſtament are to be drawn. The printed editions are either copies of more ancient editions, or of manuſcripts; and they have no further authority than as they correſpond to the manuſcripts from which they were originally taken. By manuſcripts of the New Teſtament, we mean thoſe only which were written before the invention of printing. The moſt ancient of theſe are loſt, and there is no manuſcript now extant older than the ſixth century. Few contain the whole New Teſtament; ſome contain the four goſpels; ſome the Acts of the Apoſtles and Epiſtles; and others the book of Revelation. The greateſt number are thoſe which contain the firſt part; thoſe which have the ſecond, or the firſt and ſecond together, are likewiſe numerous; but thoſe of the third are extremely few. It muſt be added alſo, that in many manuſcripts thoſe epiſtles are omitted whoſe divine authority was formerly doubted.

There are many manuſcripts which have been examined only for a ſingle text, ſuch as 1 John v. 7. or at leaſt for a very ſmall number. Others have been examined from the beginning to the end, but not completely and in reſpect of all the readings. A third claſs conſiſts of ſuch as either have been, or are ſaid to have been, completely and accurately collated. But this requires ſuch phlegmatic patience, that we can hardly expect to find in critical catalogues all the various readings which have been only once collated. Wetſtein, in collating many manuſcripts anew, made diſcoveries which had entirely eſcaped the notice of his predeceſſors. The fourth claſs conſiſts of ſuch as have been completely and accurately collated more than once; but here alſo we are in danger of being led into error.—When various readings are transferred from one critical edition to another, as from that of Gregory to Mill's edition, and from the latter to thoſe of Bengel and Wetſtein, the manuſcripts muſt ſometimes be falſely named, and various readings muſt frequently be omitted. And as Wetſtein has marked by ciphers manuſcripts that in former editions had been denoted by their initial letters, he could ſcarcely avoid ſubſtituting, in ſome caſes, one figure inſtead of another. The fifth claſs, which is by far the moſt valuable, conſiſts of ſuch as have

Scripture. have been printed word for word, and therefore form an original edition of the Greek Testament. We can boast but of a very few manuscripts of this kind. Hearne printed at Oxford, in 1715, the acts of the Apostles in Greek and Latin from the Codex Laudianus 3.; Knittel has annexed to his edition of Ulphilas, p. 53—118, a copy of two very ancient fragments preserved in the library of Wolfenbuttle; the one of the four Gospels in general, the other of St Luke and St John. Woide printed in 1786 the Codex Alexandrinus, a manuscript of great antiquity, which shall afterwards be more fully described; and the University of Cambridge has resolved to publish, in a similar manner, the Cod. Cant. I. or, as it is sometimes called, the Codex Bezæ, the care of which is intrusted to Dr Kipling, a publication which will be thankfully received by every friend to sacred criticism. It was the intention of the Abbé Spoletti, a few years ago, to publish the whole of the celebrated Codex Vaticanus; which would likewise have been a most valuable accession, since a more important manuscript is hardly to be found in all Europe. He delivered for this purpose a memorial to the pope; but the design was not put into execution, either because the pope refused his assent or the abbé abandoned it himself. See the Oriental Bible, vol. xxii. n° 333. and vol. xxiii. n° 348.

130 Michaelis's proposal of taking an impression of ancient manuscripts, vol. ii. p. 182.

"A very valuable library," says Michaelis, "might be composed of the impressions of ancient manuscripts, which, though too expensive for a private person, should be admitted into every university collection, especially the Alexandrian and Cambridge manuscripts, to which I would add, if it were now possible to procure it, Hearne's edition of the Codex Laudianus 3. A plan of this sort could be executed only in England, by a private subscription, where a zeal is frequently displayed in literary undertakings that is unknown in other countries; and it were to be wished that the project were begun before length of time has rendered the manuscripts illegible, and the attempt therefore fruitless. Ten thousand pounds would go a great way towards the fulfilling of this request, if the learned themselves did not augment the difficulty of the undertaking, by adding their own critical remarks, and endeavouring thereby to recommend their publications, rather than by presenting to the public a faithful copy of the original. Should posterity be put in possession of faithful impressions of important manuscripts, an acquisition which would render the highest service to sacred criticism, all these editions of the New Testament should be regulated on the same plan as Hearne's edition of the Acts of the Apostles." It must be highly flattering to the patriotic spirit of an Englishman to hear the encomiums which learned foreigners have so profusely bestowed on our liberality in supporting works of genius and learning and public utility. The plan which Michaelis proposes to us, in preference to all the other nations in Europe, is noble and magnificent, and would certainly confer immortality on those men who would give it their patronage and assistance. Scripture.

There are many ancient manuscripts, especially in Italy, which have never been collated, but lie still unexplored. Here is a field where much remains to be done. See Marsh's Notes to Michaelis, vol. ii. p. 643.

Michaelis has given a catalogue of ancient manuscripts, amounting in number to 292, to which he has added a short account of each. In this place we shall confine our observations to the most celebrated, the Alexandrian and Vatican manuscripts, which we have chiefly extracted from Michaelis.

131 Account of the Alexandrian manuscript.

The *Alexandrian manuscript* consists of four volumes; the first three of which contain the Old Testament, the fourth the New Testament, together with the first Epistle of Clement to the Corinthians, and a fragment of the second. In the New Testament, which alone is the object of our present inquiry, is wanting the beginning as far as Matthew xxv. 6. ὁ νυμφιος ερχεται; likewise from John vi. 50. to viii. 52. and from 2 Cor. iv. 13. to xii. 7. It must likewise be observed, that the Psalms are preceded by the epistle of Athanasius to Marcellinus, and followed by a catalogue, containing those which are to be used in prayer for each hour, both of the day and of the night; also by 14 hymns, partly apocryphal, partly biblical, the 11th of which is an hymn in praise of the Virgin Mary, entitled προσευχη μαριας της θεοτοκου: further, the *Hypotheses Eusebii* are annexed to the Psalms, and his *Canones* to the Gospels. It is true, that this has no immediate reference to the New Testament, but may have influence in determining the antiquity of the manuscript itself.

It has neither accents nor marks of aspiration; it is written with capital, or, as they are called, *uncial letters*, and has very few abbreviations. There are no intervals between the words; but the sense of a passage is sometimes terminated by a point, and sometimes by a vacant space. Here arises a suspicion that the copyist did not understand Greek, because these marks are sometimes found even in the middle of a word, for instance Levit. v. 4. ανομος η for αν ομοση, and Numb. xiii. 29. μω Υσης.

This manuscript was presented to Charles I. in 1628, by Cyrillus Lucaris patriarch of Constantinople. Cyrillus himself has given the following account; "We know so much of this manuscript of the holy writings of the Old and New Testament, that Thecla an Egyptian lady of distinction (*nobilis fœmina Ægyptia*) wrote it with her own hand 1300 years ago (A). She lived soon after the council of Nice. Her name was formerly at the end of the book; but when Christianity was subverted in Egypt by the errors of Mahomet, the books of the Christians suffered the same fate, and the name of Thecla

(A) He wrote this in the year 1628. According to this account, then, the manuscript must have been written in 328; a date to which so many weighty objections may be made, that its most strenuous advocates will hardly undertake to defend it. But this error has furnished Oudin with an opportunity of producing many arguments against the antiquity of the *Codex Alexandrinus*, which seem to imply, that Grabe and others, who have referred it to the fourth century, suppose it to have been written in the above-mentioned year. Now it is probable, that the inference which has been deduced from the account of Cyrillus is more than he himself intended to express, as he relates that Thecla lived after the council of Nice.

Scripture. Thecla was expunged. But oral tradition of no very ancient date (*memoria et traditio recens*) has preserved the remembrance of it.

But the reader will see that this account is merely traditional. Dr Semler very properly observes, that there is no more reason to rely on a tradition respecting the transcriber of an ancient manuscript, than on a tradition which relates to an ancient relic. The arguments which have been urged by Wetstein, Semler, Oudin, and Woide, to fix the date of this manuscript, are so many, that it would be tedious to repeat them. But, after all, its antiquity cannot be determined with certainty, though it appears from the formation of the letters, which resemble those of the fourth and fifth centuries, and the want of accents, that it was not written so late as the tenth century. In this century it was placed by Oudin, while Grabe and Schulze have referred it to the fourth, which is the very utmost period that can be allowed, because it contains the epistles of Athanasius. Wetstein, with more probability, has chosen a mean between these two extremes, and referred it to the fifth century: but we are not justified in drawing this inference from the formation of the letters alone, for it is well known that the same mode of forming the letters was retained longer in some countries and in some monasteries than in others.

We are now in possession of a perfect impression of this manuscript, which is accompanied with so complete and so critical a collection of various readings, as is hardly to be expected from the edition of any other manuscript. Dr Woide published it in 1786, with types cast for that purpose, line for line, without intervals between the words, as in the manuscript itself: the copy is so perfect a resemblance of the original, that it may supply its place. Its title is *Novum Testamentum Græcum e codice MS. Alexandrino qui Londini in Bibliotheca Musei Britannici asservatur descriptum.* It is a very splendid folio; and the preface of the learned editor contains an accurate description of the manuscript, with an exact list of all its various readings, that takes up no less than 89 pages; and each reading is accompanied with a remark, in which is given an account of what his predecessors Juninus, Walton, Fell, Mill, Grabe, and Wetstein, had performed or neglected.

132 Account of the Vatican manuscript.

The *Vatican manuscript* contained originally the whole Greek Bible, including both the Old and New Testament; and in this respect, as well as in regard to its antiquity, it resembles none so much as the *Codex Alexandrinus*, but no two manuscripts are more dissimilar in their readings, in the New Testament as well as in the Old. After the Gospels, which are placed in the usual order, come the Acts of the Apostles, which are immediately followed by the seven catholic epistles. This must be particularly noted, because some have contended that the second Epistle of St Peter, with the second and third of St John, were wanting. Professor Hwiid, in a letter dated Rome, April 12. 1781, assured Michaelis that he had seen them with his own eyes, that the second Epistle of St Peter is placed folio 1434, the second of St John fol. 1442, the third fol. 1443: then follow the Epistles of St Paul, but not in the usual order; for the Epistle to the Hebrews is placed immediately after those to the Thessalonians: and it is not improbable, that in the more ancient manuscript, from which the *Codex Vaticanus* was copied, this Epistle was even placed before that to the Ephesians, and immediately after the Epistle to the Galatians (B); for the Epistles of St Paul are divided into 93 sections by figures written in the margin with red ink; but the Epistle to the Galatians ends with 59, and that to the Ephesians begins with 70; the Epistle to the Hebrews, on the contrary, begins with 60, and ends with 69. With the words ἀμωμον τῷ Θεῷ, Heb. ix. 14. the manuscript ceases, the remaining leaves being lost. There is wanting, therefore, not only the latter part of this Epistle, but the Epistles to Timothy, Titus, and Philemon, with the Revelation of St John: but this last book, as well as the latter part of the Epistle to the Hebrews, has been supplied by a modern hand in the 15th century. In many places the faded letters have been also retouched by a modern, but careful hand; and when the person who made these amendments, who appears to have been a man of learning, found a reading in his own manuscript which differed from that of the *Codex Vaticanus*, he has noted it in the margin, and has generally left the text itself untouched, though in some few examples he has ventured to erase it.

It is certain, that this manuscript is of very high antiquity, though it has been disputed which of the two in this respect is entitled to the preference, the *Vaticanus* or *Alexandrinus*. The editors of the Roman edition of the Septuagint, in 1587, referred the date of the Vatican manuscript to the fourth century, the period to which the advocates for its great rival refer the *Codex Alexandrinus*. More moderate, and perhaps more accurate, are the sentiments of that great judge of antiquity Montfaucon, who, in his *Bibliotheca Bibliothecarum*, p. 3. refers it to the fifth or sixth century; and adds, that though he had seen other manuscripts of equal antiquity, he had found none at the same time so complete.

The *Codex Vaticanus* has a great resemblance to the manuscripts noted by Wetstein, C. D. L. 1. 13. 33. 69. 102. and to the Latin, Coptic, and Ethiopic versions; but it is preferable to most of them, in being almost entirely free from those undeniable interpolations and arbitrary corrections which are very frequently found in the above-mentioned manuscripts, especially in D. 1. and 69. It may be applied, therefore, as a mean not only of confirming their genuine readings, but of detecting and correcting those that are spurious. It is written with great accuracy, and is evidently a faithful copy of the more ancient manuscript from which it was transcribed. Peculiar readings, or such as are found neither in other manuscripts nor ancient versions, are seldom discovered in the *Codex Vaticanus*; and of the few which have been actually found, the greatest part are of little importance. But in proportion as the number of such readings is small, the number of those s great; in support of which few only, though ancient authorities,

(B) Probably because the Epistle to the Hebrews, as well as the Epistle to the Galatians, relates to the abolition of the Mosaic law.

Scripture. authorities, have been hitherto produced: But this manuscript has not throughout the whole New Testament the same uniform text.

As we have now a beautiful printed edition of the Alexandrian manuscript by Dr Woide, it is much to be wished that we had also an exact impression of the Vatican manuscript. From the superstitious fears and intolerant spirit of the inquisition at Rome, all access to this manuscript was refused to the Abbé Spoletti, who presented a memorial for that purpose. Unless the pope interpose his authority, we must therefore despair of having our wishes gratified; but from the liberality of sentiment which the head of the Catholic church has shown on several occasions, we hope that the period is not far distant when the Vatican library will be open to the learned, and when the pope will think it his greatest honour to encourage their researches.

133 The best editions of the Greek New Testament are those of Mill.

The most valuable editions of the Greek New Testament are those of Mill, Bengel, and Wetstein.

The edition of Mill, which was only finished 14 days before his death, occupied the attention of the author for 30 years.

The collections of various readings which had been made before the time of Mill, the Velesian, the Barberini, those of Stephens, the London Polyglot, and Fell's edition, with those which the Bishop had left in manuscript, and whatever he was able to procure elsewhere, he brought together into one large collection. He made likewise very considerable additions to it. He collated several original editions more accurately than had been done before: he procured extracts from Greek manuscripts which had never been collated; and of such as had been before collated, but not with sufficient attention, he obtained more complete extracts. It is said that he has collected from manuscripts, fathers, and versions, not fewer than 30,000 various readings. This collection, notwithstanding its many imperfections, and the superiority of that of Wetstein, is still absolutely necessary to every critic: for Wetstein has omitted a great number of readings which are to be found in Mill, especially those which are either taken from the Vulgate, or confirm its readings. Mill was indeed too much attached to this version; yet he cannot be accused of partiality in producing its evidence, because it is the duty of a critic to examine the witnesses on both sides of the question: and Wetstein, by too frequently neglecting the evidence in favour of the Vulgate, has rendered his collection less perfect than it would otherwise have been. He likewise added, as far as he was able, readings from the ancient versions; and is much to be commended for the great attention which he paid to the quotations of the fathers; the importance of which he had sagacity enough to discern.

It cannot, however, be denied, that Mill's Greek Testament has many imperfections, and some of real importance. His extracts from manuscripts often are not only incomplete, but erroneous; and it is frequently necessary to correct his mistakes from the edition of Wetstein. His extracts from the oriental versions are also imperfect, because he was unacquainted with these languages; and in selecting readings from the Syriac, the Arabic, and Ethiopic, he was obliged to have recourse to the Latin translations, which are annexed to those versions in the London Polyglot.

The great diligence which Mill had shown in collecting so many various readings, alarmed the clergy as if the Christian religion had been in danger of subversion. It gave occasion for a time to the triumphs of the deist, and exposed the author to many attacks. But it is now universally known, that not a single article of the Christian religion would be altered though a deist were allowed to select out of Mill's 30,000 readings whatever he should think most inimical to the Christian cause.

134 Bengel.

In 1734, Bengel abbot of Alpirspach, in the duchy of Wurtemburg, published a new edition of the Greek Testament. The fears which Mill had excited began to subside on this new publication; for Bengel was universally esteemed a man of piety. Bengel was not only diligent in the examination of various readings, but in the strictest sense of the word conscientious; for he considered it as an offence against the Deity, if, through his own fault, that is, through levity or carelessness, he introduced a false reading into the sacred text. His object was not merely to make a collection of readings, and leave the choice of them to the judgement of the reader, but to examine the evidence on both sides, and draw the inference; yet he has not given his own opinion so frequently as Mill, whom he resembled in his reverence for the Latin version, and in the preference which he gave to harsh and difficult readings, before those which were smooth and flowing. It may be observed in general, that he was a man of profound learning, and had a cool and sound judgement, though it did not prevent him from thinking too highly of the Latin readings, and of the *Codex Alexandrinus*, with other Latinizing manuscripts.

The imperfections of Bengel's edition arise chiefly from his diffidence and caution. He did not venture to insert into the text any reading which had not already appeared in some printed edition, even though he believed it to be the genuine reading. In the book of Revelation indeed he took the liberty to insert readings which had never been printed; because few manuscripts had been used in the printing of that book.

135 and of Wetstein.

The celebrated edition of John James Wetstein, which is the most important of all, and the most necessary to those engaged in sacred criticism, was published at Amsterdam in 1751 and 1752, in two volumes folio. No man will deny that Wetstein's *Prolegomena* discover profound erudition, critical penetration, and an intimate acquaintance with the Greek manuscripts. It is a work which in many respects has given a new turn to sacred criticism, and no man engaged in that study can dispense with it. Wherever Wetstein has delivered his sentiments respecting a Greek manuscript, which he has done less frequently than Mill, and indeed less frequently than we could have wished, he shows himself an experienced and sagacious critic. He is likewise more concise than Mill in delivering his opinion, and does not support it by producing so great a number of readings from the manuscript in question. This conciseness is the consequence of that warmth and haste which were peculiar to Wetstein's character, and which have sometimes given birth to mistakes. The fire of his disposition was likewise the cause of his advancing conjectures, in regard to the history of his manuscripts, which exceed the bounds of probability. But the critical

Scripture. tical rules which he has delivered are perfectly juſt; and in this reſpect there is a remarkable agreement between him and his eminent predeceſſors Mill and Bengel. In regard to the Latin verſion alone they appear to differ: in Mill and Bengel it has powerful, and perhaps partial, advocates; but in Wetſtein a ſevere and ſagacious judge, who ſometimes condemns it without a cauſe. The Greek manuſcripts which confirm the readings of the Vulgate, and which he ſuppoſed had been corrupted from it, he of courſe condemned with equal ſeverity: and ſome collections of various readings which had been made by Catholics, he made no ſcruple to pronounce a forgery, ſaying, "*Timeo Danaos et dona ferentes.*" But in conſequence of his antipathy to the Vulgate, his collection of various readings is leſs perfect than it might have been.

It has been aſked, 1. Whether he has quoted his manuſcripts either falſely or imperfectly, in order to eſtabliſh his own religious opinions? or, 2. Whether his diligence and accuracy have been ſuch that we may at all times depend upon them? To the firſt of theſe queſtions there can be no other anſwer, than that Wetſtein, in his character of a critic, is perfectly honeſt. With reſpect to the ſecond, his diligence and accuracy, Michaelis thinks there is leſs reaſon to pronounce him faultleſs. But Mr Marſh has examined the examples on which Michaelis founds his aſſertion, and declares that Michaelis is miſtaken in every one of them.

The diligence of Wetſtein can ſcarcely be queſtioned by any who are acquainted with his hiſtory. He travelled into different countries, and examined with his own eyes a much greater number of manuſcripts than any of his predeceſſors. His collection of various readings amounts to *above a million;* and he has not only produced a much greater quantity of matter than his predeceſſors, but has likewiſe corrected their miſtakes. The extracts from manuſcripts, verſions, and printed editions of the Greek Teſtament, which had been quoted by Mill, are generally quoted by Wetſtein. Whenever Wetſtein had no new extracts from the manuſcripts quoted by Mill, or had no opportunity of examining them himſelf, he copied literally from Mill; but wherever Mill has quoted from printed editions, as from the margin of Robert Stephens's for inſtance, or from the London Polyglot, Wetſtein did not copy from Mill, but went to the original ſource, as appears from his having corrected many miſtakes in Mill's quotations.

In the opinion of Michaelis, there are many defects in the edition of Wetſtein, which require to be ſupplied, and many errors to be corrected. Yet ſtill it muſt be allowed to be a work of immenſe labour, and moſt valuable to thoſe engaged in ſacred criticiſm; and it is ſurpriſing, when we conſider the difficulties and labour which Wetſtein had to encounter, that his errors and imperfections are ſo few.

The propoſal of Michaelis, however, of a new collation of manuſcripts, in order to form a complete collection of various readings, is worthy the attention of the learned. In mentioning this propoſal, Michaelis turns a wiſhful eye towards Britain, the only country, he ſays, which poſſeſſes the will and the means to execute the taſk. Should a reſolution, he adds, be formed in this iſland, ſo happily ſituated for promoting the purpoſes of general knowledge, to make the undertaking a public concern, to enter into a ſubſcription, and to employ men of abilities in collating manuſcripts both at home and abroad, they would be able to do more in ten years than could otherwiſe be done in a century. And could this nation direct its attention to any object more glorious or more uſeful than in aſcertaining the text of the ſacred Scriptures, and giving to poſterity an accurate edition?

Punctuation of the New Teſtament. As the ſenſe of Scripture, as well as all other books, is affected by the punctuation, it is of importance to determine whether the ſtops or points which we find in the ſacred books were uſed by the ſacred writers, or have been inſerted by modern tranſcribers.

We are told by Montfaucon, in his *Palæographia Græca*, p. 31. that the perſon who firſt diſtinguiſhed the ſeveral parts of a period in Greek writing, by the introduction of a point, was Ariſtophanes of Byzantium, who lived under Ptolemæus Epiphanes, in the 145th Olympiad. But though points were not uſed in books before this period, they were employed in inſcriptions above 400 years before the birth of Chriſt. See *Mont. Pal. Græc.* p. 135.

Under the article PUNCTUATION we mentioned, on authority which we reckoned unqueſtionable, that the ancient manuſcripts were written without any points. We have now, however, diſcovered, from Woide's edition of the *Codex Alexandrinus*, that points are uſed in that manuſcript, though omitted in the *fac ſimile* given by Montfaucon. That they are found too in the *Codex Vaticanus*, though not frequently, is related by Birch in his *Prolegomena*, p. 14.

As the fact has not been generally known, that the ancients pointed their manuſcripts, and as it is an important and intereſting fact, we ſhall preſent our readers with the firſt ſix lines of St John's Goſpel, as they are pointed in the Alexandrian manuſcript:

ΕΝΑΡΧΗΗΝΟΛΟΓΟΣΚΑΙΟΛΟΓΟΣΗΝ
ΠΡΟΣΤΟΝΘΝ ΚΑΙΘΣΗΝΟΛΟΓΟΣ·
ΟΥΤΟΣΗΝΕΝΑΡΧΗΠΡΟΣΤΟΝΘΝ
ΠΑΝΤΑΔΙΑΥΤΟΥΕΓΕΝΕΤΟ·ΚΑΙΧΩ
ΡΕΙΣΑΥΤΟΥΕΓΕΝΕΤΟΟΥΔΕΕΝ·
ΟΓΕΓΟΝΕΝΕΝΑΥΤΩΖΩΗΗΝ·

Whether any points for marking the ſenſe were uſed by the apoſtles, cannot be determined; but the points now in uſe have been invented ſince.

In the fourth century, Jerome began to add the comma and colon to the Latin verſion; and they were then inſerted in many more ancient manuſcripts. In the fifth century, Euthalius a deacon of Alexandria divided the New Teſtament into lines. This diviſion was regulated by the ſenſe, ſo that each line ended where ſome pauſe was to be made in ſpeaking. And when a copyiſt was diſpoſed to contract his ſpace, and therefore crowded the lines into each other, he then placed a point where Euthalius had terminated the line. In the eighth century, the ſtroke was invented which we call a comma. In the Latin manuſcripts, Jerome's points were introduced by Paul Warnfried and Alcuin, at the command of Charlemagne. In the ninth century, the Greek note of interrogation (;) was firſt uſed. At the invention of printing the editors placed the points

Scripture. points arbitrarily, probably without bestowing the necessary attention; and Stephens, in particular, varied his points in every edition (D).

The meaning of many passages in the Scripture has been altered by false pointing. We shall produce one instance of this: Mat. v. 34. is commonly pointed in this manner, *εγω δε λεγω υμιν, μη ομοσαι ολως· μητε εν τῳ ουρανῳ*, and consequently translated, "But I say unto you, swear not at all." But if, instead of the colon placed after *ολως*, we substitute a comma, the translation will be, "But I say to you that you ought by no means to swear, either by heaven, for it is his throne, or by earth, for it is his footstool." The command of Christ therefore applies particularly to the abuse of oaths among the Pharisees, who on every trivial occasion swore by the heaven, the earth, the temple, the head, &c. but it implies no prohibition to take an oath in the name of the Deity on solemn and important occasions.

137 Division into chapters.

The ancients divided the New Testament into two kinds of chapters, some longer and some shorter. This method appears to be more ancient than St Jerome, for he expunged a passage from the New Testament which makes an entire chapter. The longer kind of chapters were called *breves*, the shorter *capitula*. St Matthew contained, according to Jerome, 68 breves; Mark contained 48; Luke 83; and John 18. All the evangelists together consisted of 217 breves and 1126 capitula. The inventor of our modern division into chapters was Hugo de S. Caro, a French Dominican friar, who lived in the 13th century.

The ancients had two kinds of verses, one of which they called *στιχοι*, and the other *ρηματα*. The *remata* were lines which contained a certain number of letters, like our printed books, and therefore often broke off in the middle of a word. Josephus's 20 books of Antiquities contained 60,000 of them, though in Ittiquis's edition there are only 40,000 broken lines.

Stichi were lines measured by the sense: according to an ancient written list mentioned by Father Simin, there were in the New Testament 18,612 of these.

138 Division into verses.

The verses into which the New Testament is now divided are more modern, and an imitation of the division of the Old Testament. Robert Stephens, the first inventor, introduced them in his edition in the year 1551. He made this division on a journey from Lyons to Paris; and, as his son Henry tells us in the preface to the Concordance of the New Testament, he made it *inter equitandum*. This phrase probably means, that when he was weary of riding, he amused himself with this work at his inn.

139 Its disadvantages.

This invention of the learned printer was soon introduced into all the editions of the New Testament; and it must be confessed, that in consulting and quoting the Scriptures, and in framing concordances for them, a subdivision into minute parts is of the greatest utility. But all the purposes of utility could surely have been gained, without adopting the hasty and indigested division of Stephens, which often breaks the sense in pieces, renders plain passages obscure, and difficult passages unintelligible. To the injudicious division of Stephens we may ascribe a great part of the difficulties which attend the interpretation of the New Testament, and a great many of those absurd opinions which have disgraced the ages of the Reformation. For as separate verses appear to the eyes of the learned, and to the minds of the unlearned, as so many detached sentences, they have been supposed to contain complete sense, and they have accordingly been explained without any regard to the context, and often in direct opposition to it. Were any modern history or continued discourse divided into fragments with as little regard to the sense, we should soon find, that as many opposite meanings could be forced upon them as have been forced upon the books of the New Testament. The division into verses has been still more injurious to the Epistles than to the Gospels, for there is a close connection between the different parts of the Epistles, which the verses entirely dissolve. It is therefore to be wished that this division into verses were laid aside. The Scriptures ought to be divided into paragraphs, according to the sense; and the figures ought to be thrown into the margin. In this way, the figures will retain their utility without their disadvantages. Dr Campbell, in his beautiful translation of the Gospels, has adopted this method with great judgement and success; and he who will read that translation, will perceive that this single alteration renders the Gospels much more intelligible, and, we may add, more entertaining (E).

140 Meaning of the word *Gospel*.

The word ΕΥΑΓΓΕΛΙΟΝ signifies any joyful tidings, and

(D) The reader will perceive that the account of the origin of points is different from that given under PUNCTUATION. But the best authors differ upon this subject. We shall perhaps reconcile the difference, by supposing that points were invented at the time here mentioned, but were not in general use till the time mentioned under the article PUNCTUATION.

(E) We shall here subjoin, as a curiosity, what the anonymous author terms *the Old and New Testament dissected*. It contains an enumeration of all the books, chapters, verses, words, and letters, which occur in the English Bible and Apocrypha. It is said to have occupied three years of the author's life, and is a singular instance of the trifling employments to which superstition has led mankind.

The OLD and NEW TESTAMENT dissected.

	Old	New	Total	Apocryph.	
Books in the Old	39	in the New 27	Total 66		
Chapters	929	260	1189	Chapters	183
Verses	23,214	7959	31,173	Verses	6081
Words	592,439	181,253	773,692	Words	152,185
Letters	2,728,100	838,380	3,566,480		

The

Scripture. and exactly correſponds to our Engliſh word GOSPEL. In the New Teſtament this term is confined to "The glad tidings of the coming of the Meſſiah." Thus, in Mat. xi. 5. our Lord ſays, "The poor have the Goſpel preached;" that is, The coming of the Meſſiah is preached to the poor. Hence the name of *Goſpel* was given to the hiſtories of Chriſt, in which the good news of the coming of the Meſſiah, with all its joyful circumſtances, are recorded.

141 Goſpel according to St Matthew.

That the Goſpel according to Matthew was compoſed, ſays Dr Campbell, by one born a Jew, familiarly acquainted with the opinions, ceremonies, and cuſtoms of his countrymen; that it was compoſed by one converſant in the ſacred writings, and habituated to their idiom; a man of plain ſenſe, but of little or no learning, except what he derived from the Scriptures of the Old Teſtament; and finally, that it was the production of a man who wrote from conviction, and had attended cloſely to the facts and ſpeeches which he related, but who in writing entertained not the moſt diſtant view of ſetting off himſelf—we have as ſtrong internal evidence as the nature of the thing will admit, and much ſtronger than that wherein the mind ninety-nine caſes out of a hundred acquieſces.

142 Its authenticity.

That the author of this hiſtory of our bleſſed Saviour was Matthew, appears from the teſtimony of the early Chriſtians. It is atteſted by Jerome, Auguſtin, Epiphanius, and Chryſoſtom, and in ſuch a manner as ſhews that they knew the fact to be uncontroverted, and judged it to be incontrovertible. Origen, who flouriſhed in the former part of the 3d century, is alſo reſpectable authority. He is quoted by Euſebius in a chapter * wherein he ſpecially treats of Origen's account of the ſacred canon. "As I have learned (ſays Origen) *by tradition* concerning the four goſpels, which alone are received without diſpute by the whole church of God under heaven; the firſt was written by Matthew, once a publican, afterwards an apoſtle of Jeſus Chriſt, *who delivered it to the Jewiſh believers, compoſed in the Hebrew language*." In another place he ſays, "Matthew writing for the Hebrews who expected him who was to deſcend from Abraham and David, ſays the lineage of Jeſus Chriſt, ſon of David, ſon of Abraham." It muſt be obſerved, that the Greek word παραδοσις does not exactly correſpond to the Engliſh word *tradition*, which ſignifies any thing delivered orally from age to age. Παραδοσις properly implies any thing tranſmitted from former ages, whether by oral or written teſtimony. In this acceptation we find it uſed in Scripture †: "Hold the traditions (τας παραδοσεις) which ye have been taught, *whether by word* or *our epiſtle*." The next authority to which we ſhall have recourſe is that of Irenæus biſhop of Lyons, who had been a diſciple of Polycarp. He ſays in the only book of his extant, that "Matthew, among the Hebrews, wrote a goſpel in their own language, whilſt Peter and Paul were preaching the goſpel at Rome and founding the church there."

* *Hiſt.* lib. vi. cap. 25.

† Theſſ. ii. 15.

Euſeb. Hiſt. Eccl. lib. v. cap. 8.

To the teſtimony of theſe writers it may be objected, that, except Irenæus, they all lived in the third and fourth centuries, and conſequently their evidence is of little importance. But there is ſuch unanimity in the teſtimony, that it muſt have been derived from ſome authentic ſource. And is it fair to queſtion the veracity of reſpectable men merely becauſe we knew not from what writings they received their information? Many books which were then extant are now loſt; and how do we know but theſe might have contained ſufficient evidence? Irenæus at leaſt had the beſt opportunities of information, having been well acquainted in his youth with Polycarp, the diſciple of John; no objection can therefore be made to his evidence. But we can quote an authority ſtill nearer the times of the apoſtles. Papias biſhop of Hierapolis, in Cæſarea, who flouriſhed about A. D. 116, affirms that Matthew wrote his goſpel in the Hebrew tongue, which every one interpreted as he was able §. Papias was the companion of Polycarp, and beſides muſt have been acquainted with many perſons who lived in the time of the apoſtles. The fact therefore is fully eſtabliſhed, that Matthew, the apoſtle of our Saviour, was the author of that goſpel which is placed firſt in our editions of the New Teſtament.

§ *Euſeb. Hiſt. Eccl.* lib. iii. cap. 39.

The next ſubject of inquiry reſpects the language in which

The middle Chapter and the leaſt in the Bible is Pſalm 117.
The middle Verſe is the 8th of the 118th Pſalm.
The middle time is the 2d of Chronicles, 4th Chap. 16th Verſe.
The word *And* occurs in the Old Teſtament 35,543 times.
The ſame in the New Teſtament occurs 10,684 times.
The word *Jehovah* occurs 6855 times.

OLD TESTAMENT.

The middle Book is Proverbs.
The middle Chapter is Job 29th.
The middle Verſe is 2d Chron. 20th Chap. between 17th and 18th Verſes.
The leaſt Verſe is 1 Chron. 1ſt Chap. and 1ſt Verſe.

NEW TESTAMENT.

The middle Book is Theſſalonians 2d.
The middle Chapter is between the 13th and 14th Romans.
The middle Verſe is 17th Chap. Acts, 17th Verſe.
The leaſt Verſe is 11th Chap. John, Verſe 35.
The 21ſt Verſe of the 7th Chapter of Ezra has all the letters of the alphabet.
The 19th Chapter of 2d Kings and 37th of Iſaiah are alike.

Scripture.

which it was written. This we are aſſured by Papias, by Irenæus, and Origen, was the Hebrew; but the truth of this fact has been diſputed by Eraſmus, Whitby, and others. Whitby urges the improbability that Providence would have ſuffered the original of this goſpel to be loſt, and nothing to remain but a tranſlation. This is an argument of no force againſt written teſtimony; indeed we are always in danger of drawing falſe concluſions when we argue from our own opinions of the conduct of Providence: *For His ways are not as our ways, nor His thoughts as our thoughts.* But though we are forced to acknowledge that the goſpel according to Matthew which we poſſeſs is a tranſlation, it is evidently a cloſe one; and the very circumſtance that it has ſuperſeded the original, is a clear proof that it was thought equally valuable by the ancient Chriſtians. It is neceſſary to remark, that the language in which the goſpel according to Matthew was originally compoſed, and which is called Hebrew by Papias, Irenæus, and Origen, is not the ſame with the Hebrew of the Old Teſtament: it was what Jerome very properly terms Syro-Chaldaic, having an affinity to both languages, but much more to the Chaldean than to the Syrian.

143 Language in which it was written.

144 Date,

The time when this goſpel was compoſed has not been preciſely aſcertained by the learned. Irenæus ſays that "Matthew publiſhed his goſpel when Peter and Paul were preaching at Rome." Now Paul arrived at Rome A. D. 60 or 61, and it is very probable ſuffered martyrdom in A. D. 65. This may be juſtly concluded from comparing the relation of Tacitus with that of Oroſius, a writer of the fifth century. Oroſius having given an account of Nero's perſecution of the Chriſtians, and of the death of the two apoſtles in it, adds, that it was followed by a peſtilence in the city, and other diſaſters. And Tacitus relates that a peſtilence prevailed in the city, and violent ſtorms took place in Italy, in the year of Chriſt 65. Matthew's goſpel was therefore written between the year 60 and 65.

Lardner's Hiſt of the Apoſtles.

145 and deſign of it.

That this hiſtory was primarily intended for the uſe of the Jews, we have, beſides hiſtorical evidence, very ſtrong preſumptions from the book itſelf. Every circumſtance is carefully pointed out which might conciliate the faith of that nation; every unneceſſary expreſſion is avoided, which might in any way ſerve to obſtruct it. To come to particulars, there was no ſentiment relating to the Meſſiah with which the Jews were more ſtrongly poſſeſſed, than that he muſt be of the race of Abraham, and of the family of David. Matthew, therefore, with great propriety, begins his narrative with the genealogy of Jeſus. That he ſhould be born at Bethlehem in Judea, is another circumſtance in which the learned among the Jews were univerſally agreed. His birth in that city, with ſome very memorable circumſtances that attended it, this hiſtorian has alſo taken the firſt opportunity to mention. Thoſe paſſages in the prophets, or other ſacred books, which either foretel any thing that ſhould happen to him, or admit an alluſive appellation, or were in that age generally underſtood to be applicable to events which reſpect the Meſſiah, are never paſſed over in ſilence by this Evangeliſt. The fulfilment of prophecy was always to the Jews, who were convinced of the inſpiration of their ſacred writings, ſtrong evidence. Accordingly none of the Evangeliſts has been more careful than Matthew, that nothing of this kind ſhould be overlooked.

Dr Campbell's Preface to Matthew's Goſpel.

146 Diſtinguiſhing character.

That which chiefly diſtinguiſhes Matthew's writings from thoſe of the other Evangeliſts, is the minute and diſtinct manner in which he has related many of our Lord's diſcourſes and moral inſtructions. Of theſe his ſermon on the mount, his charge to the apoſtles, his illuſtrations of the nature of his kingdom, and his prophecy on Mount Olivet, are examples. He has alſo wonderfully united ſimplicity and energy in relating the replies of his maſter to the cavils of his adverſaries. Being early called to the apoſtleſhip, he was an eye and ear witneſs of moſt of the things which he relates. And there are circumſtances which incline Dr Campbell to think that Matthew has approached as near the preciſe order of time in which the events happened as any of the Evangeliſts.

Concerning the life of the apoſtle Matthew we have nothing to add, as the principal circumſtances in his life have already been mentioned. See MATTHEW.

The Goſpel according to Matthew is cited ſeven times in the epiſtle of Barnabas, twice in the firſt epiſtle of Clemens Romanus to the Corinthians, eight times in the Shepherd of Hermas, ſix times in Polycarp's ſmall epiſtle to the Philippians, and ſeven times in the ſmaller epiſtles of Ignatius. Theſe citations may be ſeen at full length in *Jones's New and Full Method of ſettling the Canon*, with the parallel paſſages in the goſpel according to Matthew.

147 Goſpel according to St Mark.

148 Its authenticity,

That Mark was the author of the goſpel which bears his name, and that it was the ſecond in the order of time, is proved by the unanimous teſtimony of the ancient Chriſtians. Many authorities are therefore unneceſſary; we ſhall only mention thoſe of Papias and Irenæus. Euſebius has preſerved the following paſſage of Papias: "This is what was related by the elder (that is, John, not the apoſtle, but a diſciple of Jeſus); Mark being Peter's interpreter wrote exactly whatever he remembered, not indeed in the order wherein things were ſpoken and done by the Lord; for he was not himſelf a hearer or follower of our Lord; but he afterwards, as I ſaid, followed Peter who gave inſtructions as ſuited the occaſions, but not as a regular hiſtory of our Lord's teaching. Mark, however, committed no miſtake in writing ſuch things as occurred to his memory: for of this one thing he was careful, to omit nothing which he had heard, and to inſert no falſehood into his narrative." Such is the teſtimony of Papias, which is the more to be regarded as he aſſigns his authority. He ſpake not from hearſay, but from the information which he had received from a moſt credible witneſs, John the elder, or preſbyter, a diſciple of Jeſus, and a companion of the apoſtles.

Hiſt. Eccl. lib. iii. cap. 39.

149 and date.

Irenæus, after telling us that Matthew publiſhed his goſpel whilſt Peter and Paul were preaching at Rome, adds: "After their departure (ἔξοδον), Mark alſo, the diſciple and interpreter of Peter, delivered to us in writing the things which had been preached by Peter." The Greek ἔξοδος, like the Engliſh word *departure*, may either denote death, which is a departure out of the world, or mean a departure out of the city. It is probably in the former of theſe ſenſes it is here uſed. Yet by the accounts given by ſome others, Mark's goſpel was publiſhed in Peter's lifetime, and had his approbation.

Adv. Haer. lib. iii. cap. 1.

Scripture. approbation. The goſpel of Mark is ſuppoſed to be but two years poſterior in date to that of Matthew. The preciſe year, however, cannot be determined with certainty; and it is a matter of no importance, ſince we have aſcertained the author and the time in which he lived.

Mark has generally been ſuppoſed to be the ſame perſon who is mentioned in the acts and ſome of Paul's epiſtles, who is called John, and was the nephew of Barnabas. But as this perſon was the attendant of Paul and Barnabas, and is nowhere in ſcripture ſaid to have accompanied Peter in his apoſtolical miſſion, which ancient writers inform us the author of the goſpel did, *Preface to Mark.* Dr Campbell has juſtly concluded that theſe were different perſons. The author of the goſpel is certainly meant by Peter when he ſays *Marcus my ſon ſaluteth you* *.

* 1 Pet v. 13.

150 Language in which it was written. That Mark wrote his goſpel in Greek, is as evidently conformable to the teſtimony of antiquity, as that Matthew wrote his in Hebrew or Syro Chaldaic. The cardinals Baronius and Bellarmine, anxious to exalt the language in which the vulgate was written, have maintained that this Evangeliſt publiſhed his work in Latin. The only appearance of teſtimony which has been produced in ſupport of this opinion is the inſcription ſubjoined to this goſpel in Syriac, and in ſome other oriental verſions. But theſe poſtſcripts are not the teſtimonies of the tranſlators: they proceed from the conjecture of ſome tranſcriber; but when written, or by whom, is equally unknown. Againſt poſitive teſtimony therefore they are entitled to no credit.

151 Deſign of it. From the Hebraiſms in the ſtyle, we ſhould readily conclude that the author was by birth and education a Jew. There are alſo expreſſions which ſhow that he had lived for ſome time among the Latins, as κεντυριων "centurion," and σπεκουλατωρ, "ſentinel;" words which do not occur in the other goſpels. There are other internal evidences that this goſpel was written beyond the confines of Judea. *Dr Campbell's Preface to Mark's Goſpel.* The firſt time the Jordan is metioned, ποταμος, "river," is added to the name for explanation; for though no perſon in Judea needed to be informed that Jordan was a river, the caſe was different in diſtant countries. The word *Gehenna*, which is tranſlated *Hell* in the New Teſtament, originally ſignified the *Valley of Hinnom*, where infants had been ſacrificed by fire to Moloch, and where a continual fire was afterwards kept up to conſume the filth of Jeruſalem. As this word could not have been underſtood by a foreigner, the Evangeliſt adds, by way of explanation, πυρ το ασβεστον, "the unquenchable fire." Inſtead of the word *Mammon*, he uſes the common term χρηματα "riches." When he employs the oriental word *Corban*, he ſubjoins the interpretation ὁ εστι δωρον, "that is, a gift." Theſe peculiarities will corroborate the hiſtorical evidence that has been already mentioned, that Mark intended his goſpel for the uſe of the Gentiles.

152 Mark not the abridger of Matthew. It has been affirmed that this evangeliſt is the abridger of Matthew. It is true that Mark ſometimes copies the expreſſions uſed by Matthew; but he is not to be conſidered as a mere abridger, for he omits altogether ſeveral things related by Matthew, viz. our Lord's pedigree, his birth, the viſit of the Magians, Joſeph's flight into Egypt, and the cruelty of Herod. Dr Lardner has given a liſt of thirty-three paſſages, wherein circumſtances are related which are omitted by the other evangeliſts. There is one parable, and an account of two miracles peculiar to Mark. The parable or ſimilitude is mentioned in chap. iv. 26. One of theſe miracles was the curing of a deaf and dumb man, chap. vii. 31, 37. The other was the giving ſight to a blind man at Bethſaida, chap. viii. 22, 26. The ſtyle of Mark, inſtead of being more conciſe than that of Matthew, is more diffuſe. That he had read Matthew's goſpel cannot be doubted, but that he abridged it, is a miſtake.

According to the teſtimony which has been already produced, Mark derived his information from the apoſtle Peter. It would be improper, therefore, not to remark, that this evangeliſt has omitted many things tending to Peter's honour, which are related in the other goſpels, and has given the moſt particular account of Peter's fall. This goſpel is ſeven times cited by Irenæus, and nine times by Tertullian. 153 but derived his information from Peter.

That the author of the goſpel which is the third in order was Luke, the companion of the apoſtle Paul, is evident from the teſtimonies of Irenæus, Clemens of Alexandria, Origen, Tertullian, and many ſucceeding writers. But it has been diſputed whether he was a Jew or a Gentile. That Luke was a Jew by birth, or at leaſt by religion, may be argued from his being a conſtant companion of Paul. If he had been an uncircumciſed Gentile, exceptions would have been made to him, eſpecially at Jeruſalem; but nothing of that kind appears. It is alſo rendered highly probable, from his mode of computing time by the Jewiſh feſtivals, and from his frequent uſe of the Hebrew idiom. It has been ſuppoſed that Luke was one of the 70 diſciples; but he does not pretend to have been a witneſs of our Lord's miracles and teaching; on the contrary, he tells us in his introduction, that he received his information from others. 154 Goſpel according to St Luke.

The deſign of Luke in writing his goſpel was to ſuperſede ſome imperfect and inaccurate hiſtories of our Saviour, which had then been publiſhed. What theſe were, it is impoſſible now to determine, as they are not mentioned by any contemporary writer, and probably did not ſurvive the age in which they were compoſed. 155 Deſign of it.

It has been ſuppoſed that Luke chiefly derived his information from the apoſtle Paul, whom he faithfully attended in his travels; but, from Luke's own words, we are led to conclude, that the principal ſource of his intelligence, as to the facts related in the goſpel, was from thoſe who had been eye and ear witneſſes of what our Lord both did and taught. Now Paul evidently was not of this number. It was from converſing with ſome of the twelve apoſtles or diſciples of our Lord, who heard his diſcourſes and ſaw his miracles, that he obtained his information. 156 From what ſource of information it was derived.

As to the time when this goſpel was written, we have hardly any thing but conjecture to guide us. But as Origen, Euſebius, and Jerome, have ranged it after thoſe of Matthew and Mark we have no reaſon to doubt but they were written in the ſame order.

The goſpel by Luke has ſupplied us with many intereſting particulars which had been omitted both by Matthew and Mark. It has given a diſtinct narration of the circumſtances attending the birth of John the Baptiſt and the nativity of our Saviour. It has given 157 Has ſupplied many omiſſions of the two former goſpels.

Scripture. an account of feveral memorable incidents and cures which had been overlooked by the reft; the converfion of Zaccheus the publican; the cure of the woman who had been bowed down for 18 years; the cure of the dropfical man; the cleanfing of the ten lepers; the inhofpitable treatment of our Saviour by the Samaritans, and the inftructive rebuke which he gave on that occafion to two of his difciples for their intemperate zeal; alfo the affecting interview which he had after his refurrection with two of his difciples. Luke has alfo added many edifying parables to thofe which the other evangelifts had recorded. Moft of thefe are fpecified by Irenæus as particularly belonging to this gofpel, and has thereby fhown to us, without intending it, that the gofpel of Luke was the fame in his time that it is at prefent.

Dr Campbell: Preface to Luke's Gofpel.

158 Style and compofition of it.

The ftyle of this evangelift abounds as much with Hebraifms as any of the facred writings, but it contains more of the Grecian idiom than any of them. It is alfo diftinguifhed by greater variety and copioufnefs; qualities which may be juftly afcribed to the fuperior learning of the author. His occupation as a phyfician would naturally induce him to employ fome time in reading, and give him eafier accefs to the company of the great than any of the other evangelifts. As an inftance of Luke's copioufnefs, Dr Campbell has remarked that each of the evangelifts has a number of words which are ufed by none of the reft; but in Luke's gofpel the number of fuch peculiarities or words, ufed in none of the other gofpels, is greater than that of the peculiar words found in all the three other gofpels put together; and that the terms peculiar to Luke are for the moft part long and compound words. The fame judicious writer has alfo obferved, that there is more of compofition in Luke's fentences than is found in the other three, and confequently lefs fimplicity. Of this the very firft fentence is an example, which occupies no lefs than four verfes. Luke, too, has a greater refemblance to other hiftorians, in giving what may be called his own verdict in the narrative part of this work; a freedom which the other evangelifts have feldom or never ventured to ufe. He calls the Pharifees *lovers of money*; in diftinguifhing Judas Ifcariot from the other Judas, he ufes the phrafe, *he who proved a traitor*, (ος και εγενετο προδοτης). Matthew and Mark exprefs the fame fentiment in milder language, "he who delivered him up." In recording the moral inftructions of our Lord, efpecially his parables, this evangelift has united an affecting fweetnefs of manner with genuine fimplicity.

Chap xvi. 14.

159 Cited by ancient Chriftian authors.

This gofpel is frequently cited by Clemens Romanus, the contemporary of the Apoftles, by Ignatius, and Juftin Martyr. Irenæus has made above a hundred citations from it. In his lib. iii. *adv. Haref.* c. 14. he vindicates the authority and perfection of Luke's gofpel, and has produced a collection of thofe facts which are only recorded by this evangelift.

160 Gofpel according to John.

That the gofpel which is placed laft in our editions of the New Teftament was written by John, one of our Saviour's apoftles, is confirmed by the unanimous teftimony of the ancient Chriftians. He was the fon of Zebedee, a fifherman of Bethfaida in Galilee, by his wife Salome, and the brother of James, furnamed the elder or greater. He was the beloved difciple of our Saviour, and was honoured, along with Peter and James, with many marks of diftinction which were not conferred on the other difciples. He poffeffed a high degree of intrepidity and zeal, a warm and affectionate heart, and was ftrongly attached to his mafter. His brother James and he were honoured with the title of Boanerges, or *Sons of Thunder*. He was anxious to reftrain whatever he confidered as a mark of difrefpect againft his mafter, and to punifh his enemies with feverity. He was incenfed againft fome perfons for attempting to caft out demons in the name of Jefus; and required them to defift becaufe they were not his difciples. James and he propofed to our Saviour to call down fire from heaven to punifh the inhofpitable Samaritans. Nor was the courage of John lefs ardent than his zeal. When Peter had difowned his Lord, and all the other difciples had fled, John continued to attend his mafter. He was prefent at his trial, and followed him to the crofs, where he was a fpectator of his fufferings and death. The interview between Jefus and this difciple at Calvary, though concifely related, is an event which will ftrongly affect every man of feeling, while it convinces him of the unalterable affection of Jefus to his beloved difciple, as well as difcovers his refpectful tendernefs for his mother. See JOHN. 161

Motives for writing it.

The ancients inform us, that there were two motives which induced John to write his gofpel: the one, that he might refute the herefies of Cerinthus and the Nicolaitans, who had attempted to corrupt the Chriftian doctrine; the other motive was, that he might fupply thofe important events in the life of our Saviour which the other evangelifts had omitted. Of the former of thefe motives Irenæus gives us the following account: "John, defirous to extirpate the errors fown in the minds of men by Cerinthus, and fome time before by thofe called Nicolaitans, publifhed his gofpel; wherein he acquaints us that there is one God, who made all things by his word, and not, as they fay, one who is the Creator of the world, and another who is the father of the Lord; one the fon of the Creator, and another the Chrift, from the fupercaeleftial abodes who defcended upon Jefus, the fon of the Creator, but remained impaffible, and afterwards fled back into his own pleroma or fulnefs." As Irenæus is the moft ancient author who has written upon this fubject, many appeals 162 have been made to his authority. The authority of Irenæus is certainly refpectable, and we have often referred to his teftimony with confidence; but we think it neceffary to make a diftinction between receiving his teftimony to a matter of fact, and implicitly adopting his opinion. He does not tell us, that he derived his information from any preceding writer, or indeed from any perfon at all. Nay, he feems to have believed that John wrote againft thefe herefies by a prophetic fpirit; for he fays in another place, chap. xx. 30. "As John the difciple of our Lord affures us, faying, But thefe are written, that ye might believe that Jefus is the Chrift, the Son of God, and that believing ye might have life through his name; *FORESEEING thefe blafphemous notions that divide the Lord, fo far as it is in their power.*"

Not to confute herefics.

Indeed it feems very improbable that an apoftle fhould write a hiftory of our Lord on purpofe to confute the wild opinions of Cerinthus or any other heretic. Had John confidered fuch a confutation neceffary, it is more likely that he would have introduced it into

Scripture. into an epiftle than blended it with the actions of his venerable Mafter. But were the opinion of Irenæus well-founded, we fhould furely difcover fome traces of it in the gofpel of John; yet except in the introduction, there is nothing that can with the leaft fhadow of probability be applied to the opinions of Cerinthus; and few, we prefume, will affirm, that the gofpel of John was compofed merely for the fake of the firft eighteen verfes.

163 But to prove that Jesus was the Meffiah the Son of God.

The intention of John in writing his gofpel was far more extenfive and important than to refute the opinions of a few men who were to fink into oblivion in the courfe of a few centuries. It was evidently (according to the opinion of Clemens of Alexandria) to fupply the omiffions of the other evangelifts: It was to exhibit the evidences of the Chriftian religion in a diftinct and perfpicuous manner: It was, as he himfelf in the conclufion of his gofpel affures us, to convince his readers, *that Jefus is the Meffiah, the Son of God, and that believing they might have life through his name* *. Now it will appear to any perfon who reads this gofpel with attention, that he has executed his plan with aftonifhing ability, and has given the moft circumftantial and fatisfactory evidence that Jefus was the Meffiah the Son of God. After declaring the pre-exiftence of Jefus, he proceeds to deliver the teftimony of John the Baptift, and felects fome of the greateft miracles of Jefus to prove his divine miffion. In the fifth chapter he prefents us with a difcourfe which our Saviour delivered in the temple in the prefence of the Jews, wherein he ftates in a very diftinct manner the proofs of his miffion from, 1. The teftimony of John; 2. His own miracles; 3. The declaration of the Father at his baptifm; 4. The Jewifh Scriptures. Indeed the conclufion that Jefus was the Meffiah the Son of God, naturally arifes from almoft every miracle which our Saviour is faid to have performed, and from every difcourfe that he delivered. This declaration is very often made by our Saviour himfelf; particularly to the woman of Samaria, to Nicodemus, and to the blind man whom he had cured.

* John xv. 31.

164 Is a fupplement to the other three gofpels.

It muft be evident to every reader, that John ftudioufly paffes over thofe paffages in our Lord's hiftory and teaching which had been treated at large by the other evangelifts, or, if he mentions them at all, he mentions them flightly. This confirms the teftimony of ancient writers, that the firft three gofpels were written and publifhed before John compofed his gofpel. Except the relation of our Saviour's trial, death, and refurrection, almoft every thing which occurs in this book is new. The account of our Saviour's nativity, of his baptifm, and of his temptation in the wildernefs, is omitted; nor is any notice taken of the calling of the twelve apoftles, or of their miffion during our Saviour's life. It is remarkable, too, that not one parable is mentioned, nor any of the predictions relating to the deftruction of Jerufalem. All the miracles recorded by the other evangelifts are paffed over, except the miraculous fupply of provifion, by which five thoufand were fed: and it is probable that this miracle was related for the fake of the difcourfe to which it gave birth. The other miracles which are mentioned are few in number, but in general they are minutely detailed. They confift of thefe: the turning of water into wine at Cana; the cure of the difeafed man at the pool of Bethefda; the cure of the man that had been blind from his birth; the reftoring of Lazarus to life; and the healing of the fervant's ear which Peter had cut off. But valuable would this gofpel be, though it had only recorded the confolation of Jefus to his difciples previous to his departure; which exhibits a moft admirable view of our Saviour's character, of his care and tender regard for his difciples. Having opened every fource of comfort to their defponding minds; exhorted them to mutual love, and to the obedience of his Father's precepts; having warned them of the impending dangers and forrows—our Saviour concludes with a prayer, in the true fpirit of piety and benevolence; ardent without enthufiafm, fober and rational without lukewarmnefs. 165

Dr Campbell's Preface to John's Gofpel.

Time at which it was written.

The time in which this gofpel was written has not been fixed with any precifion. Irenæus informs us, that it was written at Ephefus, but leaves us to conjecture whether it was written before or after John's return from Patmos. He was banifhed to Patmos by Domitian, who reigned 15 years, and according to the beft computation died A. D. 96. The perfecution which occafioned the exile of John commenced in the 14th year of Domitian's reign. If John wrote his gofpel after his return to Ephefus, which is affirmed by Epiphanius to have been the cafe, we may fix the date of it about the year 97 (F). 166

Style of it;

This gofpel is evidently the production of an illiterate Jew, and its ftyle is remarkable for fimplicity. It abounds more with Hebraifms than any of the other gofpels; and contains fome ftrong oriental figures which are not readily underftood by an European. 167

Often quoted by ancient Chriftians.

This gofpel is cited once by Clemens Romanus, by Barnabas three times, by Ignatius five times, by Juftin Martyr fix times, by Irenæus, and above forty times by Clemens Alexandrinus. 168

Acts of the apoftles.

The book which we intitle the Acts of the Apoftles connects the gofpels and the epiftles. It is evidently a continuation of Luke's gofpel, which appears both from the introduction and from the atteftations of ancient Chriftians. Both are dedicated to Theophilus; and in the beginning of the Acts a reference is made to his gofpel, which he calls *a former treatife*, recording the actions and difcourfes of Jefus till his afcenfion to heaven. Luke is mentioned as the author of the Acts of the Apoftles by Irenæus, by Tertullian, by Origen, and Eufebius.

From the frequent ufe of the firft perfon plural, it is manifeft that Luke the author was prefent at many of the

(F) It has been argued from a paffage in this gofpel, that it muft have been written before the deftruction of Jerufalem. In fpeaking of the pool of Bethefda, John ufes the prefent tenfe: His words are, "There *is* at Jerufalem." Now if thefe words had been written after the deftruction of Jerufalem, it is urged the paft tenfe would have been ufed, and not the prefent. This argument is more fpecious than forcible. Though Jerufalem was demolifhed, does it follow that the pool of Bethefda was dried up?

Scripture. the tranfactions which he relates. He appears to have accompanied Paul from Troas to Philippi. He attended him alfo to Jerufalem, and afterwards to Rome, where he remained for two years. He is mentioned by Paul in feveral of thofe epiftles which were written from Rome, particularly in the 2d epiftle to Timothy, and in the epiftle to Philemon.

This book contains the hiftory of the Chriftian church for the fpace of about 28 or 30 years, from the time of our Saviour's afcenfion to Paul's arrival at Rome in the year 60 or 61. As it informs us that Paul refided two years in Rome, it muft have been written after the year 63; and as the death of Paul is not mentioned, it is probable it was compofed before that event, which happened A. D. 65.

169 Contents of that book. The Acts of the Apoftles may be divided into feven parts. 1. The account of our Saviour's afcenfion, and of the occurrences which happened on the firft Pentecoft after that event, contained in chap. i. ii. 2. The tranfactions of the Chriftians of the circumcifion at Jerufalem, in Judea, and Samaria, chap. iii.—ix. xi. 1—21. xii. 3. Tranfactions in Cæfarea, and the admiffion of the Gentiles, chap. x. 4. The firft circuit of Barnabas and Paul among the Gentiles, chap. xi. 22. xiii. xiv. 5. Embaffy to Jerufalem, and the firft council held in that city, chap. xv. 6. Paul's fecond journey, chap. xvi.—xxi. 7. His arreftment, trial, appeal to Cæfar, and journey to Rome, chap. xxi. to the end of the book.

170 Often cited by the early Chriftians. The Acts of Apoftles are cited by Clemens Romanus, by Polycarp, by Juftin Martyr, thirty times by Irenæus, and feven times by Clemens Alexandrinus.

171 The epiftles. All the effential doctrines and precepts of the Chriftian religion were certainly taught by our Saviour himfelf, and are contained in the gofpels. The epiftles may be confidered as commentaries on the doctrines of the gofpel, addreffed to particular focieties, accommodated to their refpective fituations; intended to refute the errors and falfe notions which prevailed among them, and to inculcate thofe virtues in which they were moft deficient.

172 General plan of them. The plan on which thefe LETTERS are written is, firft, to decide the controverfy, or refute the erroneous notions which had arifen in the fociety to which the epiftle was addreffed: And, fecondly, to recommend thofe duties which their falfe doctrines might induce them to neglect; at the fame time inculcating in general exhortations the moft important precepts of Chriftian morality.

173 Arranged in chronological order. Of the epiftles fourteen were written by St Paul. Thefe are not placed according to the order of time in which they were compofed, but according to the fuppofed precedence of the focieties or perfons to whom they were addreffed. It will be proper therefore to exhibit here their chronological order according to Dr Lardner.

A TABLE of St PAUL'S EPISTLES, with the Places where, and times when, written, according to Dr Lardner.

Epiftles.	Places.		A. D.
1 Theffalonians	Corinth		52
2 Theffalonians	Corinth		52
Galatians	Corinth or Ephefus	near the end of / or beginning of	52 / 53
1 Corinthians	Ephefus	the beginning of	53
1 Timothy	Macedonia		56
Titus	Macedonia or near it	bef. the end of	56
2 Corinthians	Macedonia	about October	57
Romans	Corinth	about February	58
Ephefians	Rome	about April	61
2 Timothy	Rome	about May	61
Philippians	Rome	bef. the end of	62
Coloffians	Rome	bef. the end of	62
Philemon	Rome	bef. the end of	62
Hebrews	Rome or Italy	in Spring of	63

A TABLE of the CATHOLIC EPISTLES, and the REVELATION, according to Dr Lardner.

Epiftle.	Place.		A. D.
James	Judea	or beg. of	61 / 62
The two Epiftles of Peter	Rome		64
1 John	Ephefus	about	80
2d and 3d of John	Ephefus	between and	80 / 90
Jude	Unknown		64 or 65
Revelation	Patmos or Ephefus		95 or 96

It is more difficult to underftand the epiftolary writings than the gofpels; the caufe of which is evident. Many things are omitted in a letter, or flightly mentioned, becaufe fuppofed to be known by the perfon to whom it is addreffed. To a ftranger this will create much difficulty. The bufinefs about which St Paul wrote was certainly well known to his correfpondents; but at this diftance of time we can obtain no information concerning the occafion of his writing, of the character and circumftances of thofe perfons for whom his letters were intended, except what can be gleaned from the writings themfelves. It is no wonder, therefore, though many allufions fhould be obfcure. Befides, it is evident from many paffages that he anfwers letters and queftions which his correfpondents had fent him. If thefe had been preferved, they would have thrown more light upon many things than all the notes and conjectures of the commentators. 174 Caufes of their obfcurity.

The caufes of obfcurity which have been now mentioned are common to all the writers of the epiftles; but there are fome peculiar to St Paul. 1. As he had an acute and fertile mind, he feems to have written with great rapidity, and without attending much to the common rules of method and arrangement. To this caufe we may afcribe his numerous and long parenthefes. In the heat of argument he fometimes breaks off abruptly to follow out fome new thought; and when he has exhaufted it, he returns from his digreffion without informing his readers; fo that it requires great attention to retain the connection. 2. His frequent change of perfon, too, creates ambiguity: by the pronoun *I* he fometimes means himfelf; fometimes any Chriftian; fometimes a Jew, and fometimes any man. In ufing the pronoun WE he fometimes intends himfelf; fometimes comprehends his companions; fometimes the apoftles; 175 Caufes of obfcurity peculiar to St Paul's epiftles.

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tles; at one time he alludes to the converted Jews, at another time to the converted Gentiles. 3. There is a third cause of obscurity; he frequently proposes objections, and answers them without giving any formal intimation. There are other difficulties which arise from our uncertainty who are the persons he is addressing, and what are the particular opinions and practices to which he refers. To these we may add two external causes, which have increased the difficulty of understanding the epistles. 1. The dividing them into chapters and verses, which dissolves the connection of the parts, and breaks them into fragments. If Cicero's epistles had been so disjointed, the reading of them would be attended with less pleasure and advantage, and with a great deal more labour. 2. We are accustomed to the phraseology of the epistles from our infancy; but we have either no idea at all when we use it, or our idea of it is derived from the articles or system which we have espoused. But as different sects have arbitrary definitions for St Paul's phrases, we shall never by following them discover the meaning of St Paul, who certainly did not adjust his phraseology to any man's system.

The best plan of studying the epistles is that which was proposed and executed by Mr Locke. This we shall present to our readers in the words of that acute and judicious author.

175 Mr Locke's plan of studying the epistles.

"After I had found by long experience, that the reading of the text and comments in the ordinary way proved not so successful as I wished to the end proposed, I began to suspect that in reading a chapter as was usual, and thereupon sometimes consulting expositors upon some hard places of it, which at that time most affected me, as relating to points then under consideration in my own mind, or in debate against others, was not a right method to get into the true sense of these epistles. I saw plainly, after I began once to reflect on it, that if any one should write me a letter as long as St Paul's to the Romans, concerning such a matter as that is, in a style as foreign, and expressions as dubious as his seem to be, if I should divide it into fifteen or sixteen chapters, and read one of them to-day, and another to-morrow, &c. it is ten to one I should never come to a full and clear comprehension of it. The way to understand the mind of him that writ it, every one would agree, was to read the whole letter through from one end to the other all at once, to see what was the main subject and tendency of it: or if it had several views and purposes in it, not dependent one of another, nor in a subordination to one chief aim and end, to discover what those different matters were, and where the author concluded one, and began another; and if there were any necessity of dividing the epistle into parts, to make the boundaries of them.

"In the prosecution of this thought, I concluded it necessary, for the understanding of any one of St Paul's epistles, to read it all through at one sitting, and to observe as well as I could the drift and design of his writing it. If the first reading gave me some light, the second gave me more; and so I persisted on reading constantly the whole epistle over at once till I came to have a good general view of the apostle's main purpose in writing the epistle, the chief branches of his discourse wherein he prosecuted it, the arguments he used, and the disposition of the whole.

"This, I confess, is not to be obtained by one or two hasty readings; it must be repeated again and again with a close attention to the tenor of the discourse, and a perfect neglect of the divisions into chapters and verses. On the contrary, the safest way is to suppose that the epistle has but one business and one aim, till by a frequent perusal of it you are forced to see there are distinct independent matters in it, which will forwardly enough show themselves.

"It requires so much more pains, judgement, and application, to find the coherence of obscure and abstruse writings, and makes them so much the more unfit to serve prejudice and preoccupation when found; that it is not to be wondered that St Paul's epistles have with many passed rather for disjointed, loose, pious discourses, full of warmth and zeal, and overflows of light, rather than for calm, strong, coherent reasonings, that carried a thread of argument and consistency all through them."

Mr Locke tells us he continued to read the same epistle over and over again till he discovered the scope of the whole, and the different steps and arguments by which the writer accomplishes his purpose. For he was convinced before reading his epistles, that Paul was a man of learning, of sound sense, and knew all the doctrines of the gospel by revelation. The speeches recorded in the Acts of the Apostles convinced this judicious critic that Paul was a close and accurate reasoner: and therefore he concluded that his epistles would not be written in a loose, confused, incoherent style. Mr Locke accordingly followed the chain of the apostle's discourse, observed his inferences, and carefully examined from what premises they were drawn, till he obtained a general outline of any particular epistle. If every divine would follow this method, he would soon acquire such a knowledge of Paul's style and manner, that he would peruse his other Epistles with much greater ease.

177 Epistle to the Romans.

That the Epistle to the Romans was written at Corinth by St Paul, is ascertained by the testimony of the ancient Christians. It was composed in the year 58, in the 24th year after Paul's conversion, and is the seventh epistle which he wrote. From the Acts of the Apostles we learn that it must have been written within the space of three months; for that was the whole period of Paul's residence in Greece, (Acts xx. 1, 2, 3.)

178 Its date.

The following analysis of this epistle we have taken from a valuable little treatise, intitled A Key to the New Testament, which was written by Dr Percy bishop of Dromore. It exhibits the intention of the apostle, and the arguments which he uses to prove his different propositions, in the most concise, distinct, and connected manner, and affords the best view of this Epistle that we have ever seen.

179 General design.

"The Christian church at Rome appears not to have been planted by any apostle; wherefore St Paul, lest it should be corrupted by the Jews, who then swarmed in Rome, and of whom many were converted to Christianity, sends them an abstract of the principal truths of the gospel, and endeavours to guard them against those erroneous notions which the Jews had of justification, and of the election of their own nation.

"Now the Jews assigned three grounds for justification. First, 'The extraordinary piety and merits of their ancestors, and the covenant made by God with these holy men.' They thought God could not hate the chil-

Scripture. dren of ſuch meritorious parents; and as he had made a covenant with the patriarchs to bleſs their poſterity, he was obliged thereby to pardon their ſins.' Secondly, 'A perfect knowledge and diligent ſtudy of the law of Moſes.' They made this a plea for the remiſſion of all their ſins and vices. Thirdly, 'The works of the Levitical law,' which were to expiate ſin, eſpecially circumciſion and ſacrifices. Hence they inferred that the Gentiles muſt receive the whole law of Moſes, in order to be juſtified and ſaved.

"The doctrine of the Jews concerning election was, 'That as God had promiſed to Abraham to bleſs his ſeed, to give him not only ſpiritual bleſſings, but alſo the land of Canaan, to ſuffer him to dwell there in proſperity, and to conſider him as his church upon earth:' That therefore this bleſſing extended to their whole nation, and that God was bound to fulfil theſe promiſes to them, whether they were righteous or wicked, faithful or unbelieving. They even believed that a prophet ought not to pronounce againſt their nation the prophecies with which he was inſpired; but was rather to beg of God to expunge his name out of the book of the living.

"Theſe previous remarks will ſerve as a key to unlock this difficult Epiſtle, of which we ſhall now give a ſhort analyſis. See *Michaelis's Lectures on the New Teſtament*.

180 and analyſis of it. "I. The Epiſtle begins with the uſual ſalutation with which the Greeks began their letters, (chap. i. 1—7.)

"II. St Paul profeſſes his joy at the flouriſhing ſtate of the church at Rome, and his deſire to come and preach the goſpel (ver. 8—19.): then he inſenſibly introduces the capital point he intended to prove, viz.

"III. The ſubject of the goſpel (ver. 16, 17.), that it reveals a righteouſneſs unknown before, which is derived ſolely from faith, and to which Jews and Gentiles have an equal claim.

"IV. In order to prove this, he ſhows (chap. i. 18.—iii. 20.) that both Jews and Gentiles are 'under ſin,' i. e. that God will impute their ſins to Jews as well as to Gentiles.

"His arguments may be reduced to theſe ſyllogiſms (chap. ii. 17—24.) 1. 'The wrath of God is revealed againſt thoſe who hold the truth in unrighteouſneſs; i. e. who acknowledge the truth, and yet ſin againſt it. 2. The Gentiles acknowledged truths; but, partly by their idolatry, and partly by their other deteſtable vices, they ſinned againſt the truth they acknowledged. 3. Therefore the wrath of God is revealed againſt the Gentiles, and puniſheth them. 4. The Jews have acknowledged more truths than the Gentiles, and yet they ſin. 5. Conſequently the Jewiſh ſinners are yet more expoſed to the wrath of God (ch. ii. 1—12. Having thus proved his point, he anſwers certain objections to it. *Obj.* 1. 'The Jews were well grounded in their knowledge, and ſtudied the law.' He anſwers, If the knowledge of the law, without obſerving it, could juſtify them, then God could not have condemned the Gentiles, who knew the law by nature, (ch. ii. 13—16.) *Obj.* 2. 'The Jews were circumciſed.' *Anſ.* That is, ye are admitted by an outward ſign into the covenant with God. This ſign will not avail you when ye violate that covenant (ch. ii. 25. to the end). *Obj.* 3. 'According to this doctrine of St Paul, the Jews have no advantage before others.' *Anſ.* Yes, they ſtill have advantages; for unto them are committed the oracles of God. But their privileges do not extend to this, that God ſhould overlook their ſins, which, on the contrary, Scripture condemns even in the Jews (ch. iii. 1—19.). *Obj.* 4. 'They had the Levitical law and ſacrifices.' *Anſ.* From hence is no remiſſion, but only the knowledge of ſin. (ch. iii. 20.). Scripture.

"V. From all this St Paul concludes, that Jews and Gentiles may be juſtified by the ſame means, namely, without the Levitical law, through faith in Chriſt: And in oppoſition to the imaginary advantages of the Jews, he ſtates the declaration of Zechariah, that God is the God of the Gentiles as well as of the Jews, (ch. iii. 21. to the end.

"VI. As the whole bleſſing was promiſed to the faithful deſcendents of Abraham, which both Scripture and the Jews call his children, he proves his former aſſertion from the example of Abraham; who was an idolater before his call, but was declared juſt by God, on account of his faith, long before his circumciſion. Hence he takes occaſion to explain the nature and fruits of faith, (ch. iv. 1. v. 11.).

"VII. He goes on to prove from God's juſtice, that the Jews had no advantages over the Gentiles with reſpect to juſtification. Both Jews and Gentiles had forfeited life and immortality, by the means of one common father of their race, whom they themſelves had not choſen. Now as God was willing to reſtore immortality by a new ſpiritual head of a covenant, viz. Chriſt, it was juſt that both Jews and Gentiles ſhould ſhare in this new repreſentative of the whole race (ch. v. 12. to the end).—Chap. v. ver. 15, 16. amounts to this negative queſtion, 'Is it not fitted that the free gift ſhould extend as far as the offence?'

"VIII. He ſhows that the doctrine of juſtification, as ſtated by him, lays us under the ſtrongeſt obligations of holineſs, (ch. vi. 1. to the end).

"IX. He ſhows that the law of Moſes no longer concerns us at all; for our juſtification ariſes from our appearing in God's ſight, as if actually dead with Chriſt on account of our ſins; but the law of Moſes was not given to the dead. On this occaſion he proves at large, that the eternal power of God over us is not affected by this; and that whilſt we are under the law of Moſes we perpetually become ſubject to death, even by ſins of inadvertency, (ch. vii. 1. to the end).

"X. Hence he concludes, that all thoſe, and thoſe only, who are united with Chriſt, and for the ſake of his union, do not live according to the fleſh, are free from all condemnation of the law, and have an undoubted ſhare in eternal life, (ch. viii. 1.—17.).

"XI. Having deſcribed their bleſſedneſs, he is aware that the Jews, who expected a temporal happineſs, ſhould object to him, that Chriſtians notwithſtanding endure much ſuffering in this world. He anſwers this objection at large, (ch. viii. 18 to the end).

"XII. He ſhows that God is not the leſs true and faithful, becauſe he doth not juſtify, but rather rejects and puniſhes, thoſe Jews who would not believe the Meſſiah, (ch. ix. x. xi.). In diſcuſſing this point, we may obſerve the cautious manner in which, on account of the Jewiſh prejudices, he introduces it (ch. ix. 1.—5.), as well as in the diſcuſſion itſelf.

"He ſhows that the promiſes of God were never made to all the poſterity of Abraham, and that God al-

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Scripture. ways reserved to himself the power of choosing those sons of Abraham whom, for Abraham's sake, he intended to bless, and of punishing the wicked sons of Abraham; and that with respect to temporal happiness or misery, he was not even determined in his choice by their works. Thus he rejected Ishmael, Esau, the Israelites in the desert in the time of Moses, and the greater part of that people in the time of Isaiah, making them a sacrifice to his justice, (ch. ix. 6.—29.).

"He then proceeds to show, that God had reason to reject most of the Jews then living, because they would not believe in the Messiah, though the gospel had been preached to them plainly enough, (ch. ix. 30. x. to the end). However, that God had not rejected all the people, but was still fulfilling his promise upon many thousand natural descendants of Abraham, who believed in the Messiah, and would in a future period fulfil them upon more; for that all Israel would be converted, (ch. xi. 1—32.). And he concluded with admiring the wise counsels of God, (ver. 33. to the end).

"XIII. From the doctrine hitherto laid down, and particularly from this, that God has in mercy accepted the Gentiles; he argues, that the Romans should consecrate and offer themselves up wholly to God. This leads him to mention in particular some Christian duties, (ch. xii.), viz.

"XIV. He exhorts them to be subject to magistrates (ch. xiii. 1—7.); the Jews at that time being given to sedition.

"XV. To love one another heartily (ver. 2—10.). And,

"XVI. To abstain from those vices which were considered as things indifferent among the Gentiles, (ver. 11. to the end).

"XVII. He exhorts the Jews and Gentiles in the Christian church to brotherly unity, (ch. xiv. 2. xv. 13.).

"XVIII. He concludes his Epistle with an excuse for having ventured to admonish the Romans, whom he had not converted; with an account of the journey to Jerusalem; and with some salutations to those persons whom he meant to recommend to the church at Rome." See *Michaelis's Lectures on the New Testament*.

181 First Epistle to the Corinthians. Corinth was a wealthy and luxurious city, built upon the isthmus which joins the Morea to the northern parts of Greece. In this city Paul had spent two years founding a Christian church, which consisted of a mixture of Jews and Gentiles, but the greater part Gentiles.

182 Its date. About three years after the apostles had left Corinth, he wrote this Epistle from Ephesus in the year 56 or 57, and in the beginning of Nero's reign. That it was written from Ephesus, appears from the salutation with which the Epistle closes, (chap. xvi. 19.). "The churches of Asia salute you. Aquila and Priscilla salute you much in the Lord." From these words it is evident, in the 1st place, that the Epistle was written in Asia. 2dly, It appears from Acts xviii. 18, 19. that Aquila and Priscilla accompanied Paul from Corinth to Ephesus, where they seem to have continued till Paul's departure.

St Paul had certainly kept up a constant intercourse with the churches which he had founded; for he was evidently acquainted with all their revolutions. They seem to have applied to him for advice in those difficult cases which their own understanding could not solve; and he was ready on all occasions to correct their mistakes.

This Epistle consists of two parts. 1. A reproof for those vices to which they were most propense; 2. An answer to some queries which they had proposed to him. 183 General design of it.

The Corinthians, like the other Greeks, had been accustomed to see their philosophers divide themselves into different sects; and as they brought along with them into the Christian church their former opinions and customs, they wished, as before, to arrange themselves under different leaders. In this Epistle Paul condemns these divisions as inconsistent with the spirit of Christianity, which inculcates benevolence and unanimity, and as opposite to the conduct of Christian teachers, who did not, like the philosophers, aspire after the praise of eloquence and wisdom. They laid no claim to these nor to any honour that cometh from men. The apostle declares, that the Christian truths were revealed from heaven; that they were taught with great plainness and simplicity, and proved by the evidence of miracles, (chap. i. 1.). He dissuades them from their divisions and animosities, by reminding them of the great trial which every man's work must undergo; of the guilt they incurred by polluting the temple or church of God; of the vanity of human wisdom; and of glorying in men. He admonishes them to esteem the teachers of the gospel only as the servants of Christ; and to remember that every superior advantage which they enjoyed was to be ascribed to the goodness of God, (chap. iii. 4.). 184 The apostle reproves the Corinthians for their vices;

2. In the fifth chapter the apostle considers the case of a notorious offender, who had married his stepmother; and tells them, that he ought to be excommunicated. He also exhorts the Christians not to associate with any person who led such an openly profane life.

3. He censures the Corinthians for their litigious disposition, which caused them to prosecute their Christian brethren before the Heathen courts. He expresses much warmth and surprise that they did not refer their differences to their brethren; and concludes his exhortations on this subject, by assuring them that they ought rather to allow themselves to be defrauded than to seek redress from Heathens (chap. v. 1—9.).

4. He inveighs against those vices to which the Corinthians had been addicted before their conversion, and especially against fornication, the criminality of which they did not fully perceive, as this vice was generally overlooked in the systems of the philosophers, (chap. vi. 10. to the end).

Having thus pointed out the public irregularities with which they were chargeable, he next replies to certain questions which the Corinthians had proposed to him by letter. He, 1. Determines some questions relating to the marriage state; as, 1st, Whether it was good to marry under the existing circumstances of the church? And, 2d, Whether they should withdraw from their partners if they continued unbelievers? (chap. vii.). 185 And answers certain questions which they had proposed to him.

2. He instructs them how to act with respect to idol offerings. It could not be unlawful in itself to eat the food which had been offered to idols; for the consecration of flesh or wine to an idol did not make it the property of the idol, an idol being nothing, and therefore incapable

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incapable of property. But ſome Corinthians thought it lawful to go to a feaſt in the idol temples, which at the ſame time were places of reſort for lewdneſs, and to eat the ſacrifices while praiſes were ſung to the idol. This was publicly joining in the idolatry. He even adviſes to abſtain from ſuch participation as was lawful, rather than give offence to a weak brother; which he enforces by his own example, who had abſtained from many lawful things, rather than prove a ſcandal to the goſpel, (chap. viii. ix. x.).

3. He anſwers a third query concerning the manner in which women ſhould deliver any thing in public, when called to it by a divine impulſe. And here he cenſures the unuſual dreſs of both ſexes in propheſying, which expoſed them to the contempt of the Greeks, among whom the men uſually went uncovered and the women veiled.

Being thus led to the conſideration of the abuſes that prevailed in their public worſhip, he goes on to cenſure the irregularities which were committed at their love-feaſts, or, as we term them, the *Lord's Supper*. It was a common practice with the Greeks at their ſocial ſuppers for every man to bring his own proviſions along with him, not, however, to ſhare them with the company, but to feaſt on them in a ſolitary manner. Thus the rich ate and drank to exceſs, whilſt the poor were totally neglected. The Corinthians introduced the ſame practice in the celebration of the Lord's Supper, thus confounding it with their ordinary meals, and without ever examining into the end of the inſtitution. It was this groſs abuſe that Paul reproves in the 11th chapter. He alſo cenſures their conduct in the exerciſe of the extraordinary gifts of the Holy Ghoſt; he ſhows them they all proceeded from the ſame ſpirit, and were intended for the inſtruction of Chriſtian ſocieties; that all Chriſtians ought to be united in mutual love; and that tenderneſs ought to be ſhown to the moſt inconſiderable member, as every one is ſubſervient to the good of the whole (chap. xii.). In the 13th chapter he gives a beautiful deſcription of benevolence, which has been much and juſtly admired. He repreſents it as ſuperior to the ſupernatural gifts of the ſpirit, to the moſt exalted genius, to univerſal knowledge, and even to faith. In the 14th chapter he cautions the Corinthians againſt oſtentation in the exerciſe of the gift of languages, and gives them proper advices.

4. He aſſerts the reſurrection of the dead, in oppoſition to ſome of the Corinthians who denied it, founding it on the reſurrection of Jeſus Chriſt, which he conſiders as one of the moſt eſſential doctrines of Chriſtianity. He then anſwers ſome objections to the reſurrection, drawn from our not being capable of underſtanding how it will be accompliſhed, (chap. xv.). He then concludes with ſome directions to the Corinthian church concerning the manner of collecting alms; promiſes them a viſit, and ſalutes ſome of the members.

186 The ſecond Epiſtle to the Corinthians.

The ſecond Epiſtle to the Corinthians was written from Macedonia in the year 57, about a year after the former. See 2 Cor. ix. 1—5. viii. and xiii. 1.

187 State of the Corinthian church.

St Paul's firſt Epiſtle had wrought different effects among the Corinthians: many of them examined their conduct; they excommunicated the inceſtuous man; requeſted St Paul's return with tears; and vindicated him and his office againſt the falſe teacher and his adherents. Others of them ſtill adhered to that adverſary of St Paul, expreſsly denied his apoſtolic office, and even furniſhed themſelves with pretended arguments from that Epiſtle. He had formerly promiſed to take a journey from Epheſus to Corinth, thence to viſit the Macedonians, and return from them to Corinth (2 Cor. i. 15, 16.). But the unhappy ſtate of the Corinthian church made him alter his intention (verſe 23.), ſince he found he muſt have treated them with ſeverity. Hence his adverſaries partly argued, 1. That St Paul was irreſolute and unſteady, and therefore could not be a prophet: 2. The improbability of his ever coming to Corinth again, ſince he was afraid of them. Such was the ſtate of the Corinthian church when St Paul, after his departure from Epheſus, having viſited Macedonia, (Acts xx. 1.), received an account of the above particulars from Titus (2 Cor. vii. 5, 6.), and therefore wrote them his ſecond Epiſtle about the end of the ſame year, or the beginning of 58.

188 View of the contents of this Epiſtle.

But to give a more diſtinct view of the contents of this Epiſtle:

1. The apoſtle, after a general ſalutation, expreſſes his grateful ſenſe of the divine goodneſs; profeſſing his confidence in God, ſupported by a ſenſe of his own integrity; makes an apology for not having viſited the Corinthians as he had intended, and vindicates himſelf from the charge of fickleneſs, (chap. i.).

2. He forgives the inceſtuous man, whoſe conduct had made ſo deep an impreſſion on the apoſtle's mind, that one reaſon why he had deferred his journey to Corinth was, that he might not meet them in grief, nor till he had received advice of the effect of his apoſtolical admonitions. He mentions his anxiety to meet Titus at Troas, in order to hear of their welfare; expreſſes his thankfulneſs to God for the ſucceſs attending his miniſtry, and ſpeaks of the Corinthians as his credentials, written by the finger of God, (chap. ii. iii. 1.—6.).

3. He treats of the office committed to him of preaching the redemption; and highly prefers it to preaching the law: to which probably his adverſaries had made great pretences. They had ridiculed his ſufferings; which he ſhows to be no diſgrace to the goſpel or its miniſters; and here he gives a ſhort abſtract of the doctrine he preaches, (chap. iii. 6. v. to the end).

He expatiates with great copiouſneſs on the temper with which, in the midſt of afflictions and perſecutions, he and his brethren executed their important embaſſy; and with great affection and tenderneſs he exhorts them to avoid the pollution of idolatry, (chap. vi.). He endeavours to win their confidence, by telling them how much he rejoiced in their amendment and welfare, and how ſorry he had been for the diſtreſs which his neceſſary reproofs had occaſioned, (chap. vii.). He then exhorts them to make liberal contributions for the Chriſtians in Judæa. He recommends to them the example of the Macedonians, and reminds them of the benevolence of the Lord Jeſus. He expreſſes his joy for the readineſs of Titus to aſſiſt in making the collection; and makes alſo honourable mention of other Chriſtian brethren, whom he had joined with Titus in the ſame commiſſion, chap. viii.). He then, with admirable addreſs, urges a liberal contribution, and recommends them to the divine bleſſing, (chap. ix.).

4. Next he obviates ſome reflections which had been thrown

thrown on him for the mildneſs of his conduct, as if it had proceeded from fear. He aſſerts his apoſtolical power and authority, cautioning his opponents againſt urging him to give too ſenſible demonſtrations of it, (chap. x.). He vindicates himſelf againſt the inſinuations of ſome of the Corinthians, particularly for having declined pecuniary ſupport from the church; an action which had been ungenerouſly turned to his diſadvantage. To ſhow his ſuperiority over thoſe deſigning men who had oppoſed his preaching, he enumerates his ſufferings; gives a detail of ſome extraordinary revelations which he had received; and vindicates himſelf from the charge of boaſting, by declaring that he had been forced to it by the deſire of ſupporting his apoſtolical character, (chap. xi. xii.). He cloſes the Epiſtle, by aſſuring them with great tenderneſs how much it would grieve him to demonſtrate his divine commiſſion by ſeverer methods.

189
Epiſtle to the Galatians.

The Galatians were deſcended from thoſe Gauls who had formerly invaded Greece, and afterwards ſettled in Lower Aſia. St Paul had preached the goſpel among them in the year 51, ſoon after the council held at Jeruſalem, (Acts xvi. 6.). Aſia ſwarmed at that time with zealots for the law of Moſes, who wanted to impoſe it on the Gentiles, (Acts xv. 1.). Soon after St Paul had left the Galatians, theſe falſe teachers had got among them, and wanted them to be circumciſed, &c. This occaſioned the following Epiſtle, which Michaelis thinks was written in the ſame year, before St Paul left Theſſalonica. Dr Lardner dates it about the end of the year 52, or in the very beginning of 53, before St Paul ſet out to go to Jeruſalem by way of Epheſus.

190
The date

191
and contents of it.

The ſubject of this Epiſtle is much the ſame with that of the Epiſtle to the Romans; only this queſtion is more fully conſidered here, "Whether circumciſion, and an obſervance of the Levitical law, be neceſſary to the ſalvation of a Chriſtian convert?" It appears, theſe Judaizing Chriſtians, whoſe indirect views St Paul expoſes (Acts xv. 1. Gal. v. 3, 9.), at firſt only repreſented circumciſion as neceſſary to ſalvation; but afterwards they inſiſted upon the Chriſtians receiving the Jewiſh feſtivals, (Gal. iv. 10.).

As St Paul had founded the churches of Galatia, and inſtructed them in the Chriſtian religion, he does not ſet before them its principal doctrines, as he had done in the Epiſtle to the Romans; but referring them to what he had already taught (chap. i. 8, 9.), he proceeds at once to the ſubject of the Epiſtle.

As it appears from ſeveral paſſages of this Epiſtle, particularly chap. i. 7, 8, 10. and chap. v. 11. that the Judaizing Chriſtians had endeavoured to perſuade the Galatians that Paul himſelf had changed his opinion, and now preached up the Levitical law; he denies that charge, and affirms that the doctrines which he had taught were true, for he had received them from God by immediate revelation. He relates his miraculous converſion; aſſerts his apoſtolical authority, which had been acknowledged by the diſciples of Jeſus; and, as a proof that he had never inculcated a compliance with the Moſaic law, he declares that he had oppoſed Peter at Antioch for yielding to the prejudices of the Jews.

Having now vindicated his character from the ſuſpicion of fickleneſs, and ſhown that his commiſſion was divine, he argues that the Galatians ought not to ſubmit to the law of Moſes: 1. Becauſe they had received the Holy Ghoſt and the gift of miracles, not by the law, but by the goſpel, (chap. iii. 1—5.). 2. Becauſe the promiſes which God made to Abraham were not reſtricted to his circumciſed deſcendants, but extended to all who are his children by faith, (chap. iii. 6—18.). In anſwer to the objection, *To what then ſerveth the law?* he replies, That it was given becauſe of tranſgreſſion; that is, to preſerve them from idolatry till the Meſſiah himſelf ſhould come. 3. Becauſe all men, whether Jews or Gentiles, are made the children of God by faith, or by receiving the Chriſtian religion, and therefore do not ſtand in need of circumciſion, (chap. iii. 26—29.). From the 1ſt verſe of chap. iv. to the 11th, he argues that the law was temporary, being only fitted for a ſtate of infancy; but that the world, having attained a ſtate of manhood under the Meſſiah, the law was of no farther uſe. In the remaining part of chapter iv. he reminds them of their former affection to him, and aſſures them that he was ſtill their ſincere friend. He exhorts them to ſtand faſt in the liberty with which Chriſt had made them free; for the ſons of Agar, that is, thoſe under the law given at Mount Sinai, are in bondage, and to be caſt out; the inheritance being deſigned for thoſe only who are the free-born ſons of God under the ſpiritual covenant of the goſpel.

192
Arguments by which the apoſtle proves that the law of Moſes was not obligatory on the Galatians.
Locke on the Epiſtles.

193
How he vindicates his own character from falſe aſperſions.

The apoſtle next confutes the falſe report which had been ſpread abroad among the Galatians, that Paul himſelf preached up circumciſion. He had already indirectly refuted this calumny by the particular account which he gave of his life; but he now directly and openly contradicts it in the following manner:

1. By aſſuring them, that all who thought circumciſion neceſſary to ſalvation could receive no benefit from the Chriſtian religion, (chap. v. 2—4.).

2. By declaring, that he expected juſtification only by faith, (verſe 5, 6.).

3. By teſtifying, that they had once received the truth, and had never been taught ſuch falſe doctrines by him, (verſe 7, 8.).

4. By inſinuating that they ſhould paſs ſome cenſure on thoſe who miſled them (ver. 9, 10.), by declaring that he was perſecuted for oppoſing the circumciſion of the Chriſtians, (ver. 11.).

5. By expreſſing a wiſh that thoſe perſons ſhould be cut off who troubled them with his doctrine.

This Epiſtle affords a fine inſtance of Paul's ſkill in managing an argument. The chief objection which the advocates for the Moſaic law had urged againſt him was, that he himſelf preached circumciſion. In the beginning of the Epiſtle he overturns this ſlander by a ſtatement of facts, without taking any expreſs notice of it; but at the end fully refutes it, that it might leave a ſtrong and laſting impreſſion on their minds.

He next cautions them againſt an idea which his arguments for Chriſtian liberty might excite, that it conſiſted in licentiouſneſs. He ſhows them it does not conſiſt in gratifying vicious deſires; for none are under ſtronger obligations to moral duties than the Chriſtian. He recommends gentleneſs and meekneſs to the weak (chap. vi. 1—5.), and exhorts them to be liberal to their teachers, and to all men (ver. 6—10.). He

concludes

concludes with exposing the false pretences of the Judaizing teachers, and asserting the integrity of his own conduct.

194
Epistle to the Ephesians.

Ephesus was the chief city of all Asia on this side Mount Taurus. St Paul had passed through it in the year 54, but without making any stay, (Acts xviii. 19—21.). The following year he returned to Ephesus again, and staid there three years, (chap. xix.). During his abode there he completed a very flourishing church of Christians, the first foundations of which had been laid by some inferior teachers. As Ephesus was frequented by persons of distinction from all parts of Asia Minor, St Paul took the opportunity of preaching in the ancient countries (ver. 10.); and the other churches of Asia were considered as the daughters of the church of Ephesus; so that an Epistle to the Ephesians was, in effect, an epistle to the other churches of Asia at the same time.

195
The date

Dr Lardner shows it to be highly probable that this epistle was written in the year 61, soon after Paul's arrival at Rome.

196
and design of it.

As Paul was in a peculiar manner the apostle of the Gentiles, and was now a prisoner at Rome in consequence of having provoked the Jews, by asserting that an observance of the Mosaic law was not necessary to obtain the favour of God, he was afraid least an advantage should be taken of his confinement to unsettle the minds of those whom he had converted. Hearing that the Ephesians stood firm in the faith of Christ, without submitting to the law of Moses, he writes this Epistle to give them more exalted views of the love of God, and of the excellence and dignity of Christ. This epistle is not composed in an argumentative or didactic style: The first three chapters consist almost entirely of thanksgivings and prayers, or glowing descriptions of the blessings of the Christian religion. This circumstance renders them a little obscure; but by the assistance of the two following epistles, which were written on the same occasion, and with the same design, the meaning of the apostle may be easily discovered. The last three chapters contain practical exhortations. He first inculcates unity, love, and concord, from the consideration that all Christians are members of the same body, of which Christ is the head. He then advises them to forsake the vices to which they had been addicted while they remained heathens. He recommends justice and charity; strenuously condemns lewdness, obscenity, and intemperance, vices which seem to have been too common among the Ephesians. In the 6th chapter he points out the duties which arise from the relations of husbands and wives, parents and children, masters and servants; and concludes with strong exhortations to fortitude, which he describes in an allegorical manner.

197
Epistle to the Philippians

The church at Philippi had been founded by Paul, Silas, and Timothy (Acts xvi.), in the year 51, and had continued to show a strong and manly attachment to the Christian religion, and a tender affection for the apostle. Hearing of his imprisonment at Rome, they sent Epaphroditus, one of their pastors, to supply him with money. It appears from this epistle that he was in great want of necessaries before this contribution arrived; for as he had not converted the Romans, he did not consider himself as intitled to receive supplies from them. Being a prisoner, he could not work as formerly, and it was a maxim of his never to accept any pecuniary assistance from those churches where a faction had been raised against him. From the Philippians he was not averse to receive a present in the time of want, because he considered it as a mark of their affection, and because he was assured that they had conducted themselves as sincere Christians.

198
The date

It appears from the apostle's own words, that this letter was written while he was a prisoner at Rome, (chap. i. 7, 13. iv. 22.); and from the expectation which he discovers (chap. ii. 24.) of being soon released and restored to them, compared with Philemon v. 22. and Heb. xiii. 13. where he expresses a like expectation in stronger terms, it is probable that this epistle was written towards the end of his first imprisonment in the year 62.

199
and design of it.

The apostle's design in this epistle, which is quite of the practical kind, seems to be, "to comfort the Philippians under the concern they had expressed at the news of his imprisonment; to check a party-spirit that appears to have broken out among them, and to promote, on the contrary, an entire union and harmony of affection; to guard them against being seduced from the purity of the Christian faith by Judaizing teachers; to support them under the trials with which they struggled; and, above all, to inspire them with a concern to adorn their profession by the most eminent attainments in the divine life." After some particular admonitions in the beginning of the 4th chapter, he proceeds in the 8th verse to recommend virtue in the most extensive sense, mentioning all the different foundations in which it had been placed by the Grecian philosophers. Towards the close of the epistle, he makes his acknowledgements to the Philippians for the seasonable and liberal supply which they had sent him, as it was so convincing a proof of their affection for him, and their concern for the support of the gospel, which he preferred far above any private secular interest of his own; expresly disclaiming all selfish, mercenary views, and assuring them with a noble simplicity, that he was able upon all occasions to accommodate his temper to his circumstances; and had learned, under the teachings of Divine grace, in whatever station Providence might see fit to place him, therewith to be content. After which, the apostle, having encouraged them to expect a rich supply of all their wants from their God and Father, to whom he devoutly ascribes the honour of all, concludes with salutations from himself and his friends at Rome to the whole church, and a solemn benediction, (verse 10. to the end); and declares, that he rejoiced in their liberality chiefly on their own account.

200
Epistle to the Colossians.—Date and design of it.

The epistle to the Colossians was written while Paul was in prison (chap. iv. 3.), and was therefore probably composed in the year 62. The intention of the apostle, as far as can be gathered from the epistle itself, was to secure the Colossians from the influence of some doctrines that were subversive of Christianity, and to excite them to a temper and behaviour worthy of their sacred character. A new sect had arisen, which had blended the oriental philosophy with the superstitious opinions of the Jews.

201
To guard the Colossians against the dangerous doctrines of the Jews.

They held, 1. That God was surrounded by demons or angels, who were mediators with God, and therefore to be worshipped. 2. That the soul is defiled by the body; that all bodily enjoyments hurt the soul, which they believed to be immortal, though they seem to have denied

Scripture. denied the resurrection of the body, as it would only render the soul sinful by being reunited to it. 3. That there was a great mystery in numbers, particularly in the number seven; they therefore attributed a natural holiness to the seventh or Sabbath day, which they observed more strictly than the other Jews. They spent their time mostly in contemplation; abstained from marriage, and every gratification of the senses; used washings, and thought it sinful to touch certain things; regarded wine as poison, &c.

Percy's Key to the New Testament.

202 The arguments which the apostle employs.

The arguments against these doctrines are managed with great skill and address. He begins with expressing great joy for the favourable character which he had heard of them, and assures them that he daily prayed for their farther improvement. Then he makes a short digression, in order to describe the dignity of Jesus Christ; declares that he had created all things, whether thrones or dominions, principalities and powers; that he alone was the head of the church, and had reconciled men to the Father. The inference from this description is evident, that Jesus was superior to angels; that they were created beings, and ought not to be worshipped. Thus he indirectly confutes one doctrine before he formally opposes it. Paul now returns from his digression in the 21st verse to the sentiments with which he had introduced it in the 13th and 14th verses, and again expresses his joy that the Philippians remained attached to the gospel, which was to be preached to the Gentiles, without the restraints of the ceremonial law. Here again he states a general doctrine, which was inconsistent with the opinions of those who were zealous for the law of Moses; but he leaves the Colossians to draw the inference, (chap. i.).

Having again assured them of his tender concern for their welfare, for their advancement in virtue, and that they might acknowledge the mystery of God, that is, that the gospel was to supersede the law of Moses, he proceeds directly to caution them against the philosophy of the new teachers, and their superstitious adherence to the law; shows the superiority of Christ to the angels, and warns Christians against worshipping them. He censures the observation of Sabbaths, and rebukes those who required abstinence from certain kinds of food, and cautions them against persons who assume a great appearance of wisdom and virtue, (chap. ii.).

203 Exhortations.

In the 3d chapter he exhorts them, that, instead of being occupied about external ceremonies, they ought to cultivate pure morality. He particularly guards them against impurity, to which they had before their conversion been much addicted. He admonishes them against indulging the irascible passions, and against committing falsehood. He exhorts them to cultivate the benevolent affections, and humility, and patience. He recommends also the relative duties between husbands and wives, parents and children, masters and servants. He enjoins the duties of prayer and thanksgiving (chap. iv. 2.), and requests them to remember him in their petitions. He enjoins affability and mild behaviour to the unconverted heathens (verse 6th); and concludes the epistle with matters which are all of a private nature, except the directions for reading this epistle in the church of Laodicea, as well as in the church of Colosse.

204 First Epistle to the Thessalonians.

This epistle is addressed to the inhabitants of Thessalonica, the capital of Macedonia, a large and populous city. It appears from the Acts, chapter xvii. 1. that the Christian religion was introduced into this city by Paul and Silas, soon after they had left Philippi. At first they made many converts; but at length the Jews, ever jealous of the admission of the Gentiles to the same privileges with themselves, stirred up the rabble, which assaulted the house where the apostle and his friends lodged; so that Paul and Silas were obliged to flee to Berea, where their success was soon interrupted by the same restless and implacable enemies. The apostle then withdrew to Athens; and Timothy, at his desire, returned to Thessalonica (1 Thess. iii. 2.), to see what were the sentiments and behaviour of the inhabitants after the persecution of the Jews. From Athens Paul went to Corinth, where he stayed a year and six months; during which, Timothy returned with the joyful tidings, that the Thessalonians remained stedfast to the faith, and firmly attached to the apostle, notwithstanding his flight. Upon this he sent them this epistle, A. D. 52, in the 12th year of Claudius.

205 The date

This is generally reckoned the first epistle which Paul wrote; and we find he was anxious that it should be read to all the Christians. In chap. v. 27. he uses these words; "I adjure you by the Lord, that this epistle be read unto all the holy brethren." This direction is very properly inserted in his first epistle.

206 and design of it.

The intention of Paul in writing this epistle was evidently to encourage the Thessalonians to adhere to the Christian religion. This church being still in its infancy, and oppressed by the powerful Jews, required to be established in the faith. St Paul, therefore, in the three first chapters, endeavours to convince the Thessalonians of the truth and divinity of his gospel, both by the miraculous gifts of the Holy Ghost which had been imparted, and by his own conduct when among them.

While he appeals, in the first chapter, to the miraculous gifts of the Holy Spirit, he is very liberal in his commendations. He vindicates himself from the charge of timidity, probably to prevent the Thessalonians from forming an unfavourable opinion of his fortitude, which his flight might have excited. He asserts, that he was not influenced by selfish or dishonourable motives, but that he was anxious to please God and not man. He expresses a strong affection for them, and how anxious he was to impart the blessings of the gospel. He congratulates himself upon his success; mentions it to their honour that they received the gospel as the word of God and not of man, and therefore did not renounce it when persecution was raised by the Jews. He expresses a strong desire to visit the Thessalonians; and assures them he had been hitherto retained against his will.

As a farther proof of his regard, the apostle informs them, that when he came to Athens, he was so much concerned, least, being discouraged by his sufferings, they should be tempted to cast off their profession, that he could not forbear sending Timothy to comfort and strengthen them; and expresses, in very strong terms, the sensible pleasure he felt, in the midst of all his afflictions, from the favourable account he received of their faith and love; to which he adds, that he was continually praying for their farther establishment in religion, and for an opportunity of making them another visit, in order

 order to promote their edification, which lay fo near his heart, (chap. iii. throughout).

Having now fhown his paternal affection for them, with great addrefs he improves all that influence which his zeal and fidelity in their fervice muft naturally have given him to inculcate upon them the precepts of the gofpel. He recommends chaftity, in oppofition to the prevailing practice of the heathens; juftice, in oppofition to fraud. He praifes their benevolence, and encourages them to cultivate higher degrees of it. He recommends induftry and prudent behaviour to their heathen neighbours. In order to comfort them under the lofs of their friends, he affures them that thofe who were fallen afleep in Jefus fhould be raifed again at the laft day, and fhould, together with thofe who remained alive, be caught up to meet their Lord, and fhare his triumph, (chap. iv.). He admonifhes them to prepare for this folemn event, that it might not come upon them unawares; and then concludes the epiftle with various exhortations.

207 Second Epiftle to the Theffalonians.

The fecond epiftle to the Theffalonians appears to have been written foon after the firft, and from the fame place; for Silvanus or Silas, and Timothy, are joined together with the apoftle in the infcriptions of this epiftle, as well as of the former.

208 Contents of it.

The apoftle begins with commending the faith and charity of the Theffalonians, of which he had heard a favourable report. He expreffes great joy on account of the patience with which they fupported perfecution; and obferves that their perfecution was a proof of a righteous judgement to come, where their perfecutors would meet with their proper recompenfe, and the righteous be delivered out of all their afflictions. He affures them of his conftant prayers for their farther improvement, in order to attain the felicity that was promifed, (chap. i.).

From mifunderftanding a paffage in his former letter, it appears that the Theffalonians believed the day of judgement was at hand. To rectify this miftake, he informs them that the day of the Lord will not come till a great apoftacy has overfpread the Chriftian world, the nature of which he defcribes (G). Symptoms of this myftery of iniquity had then appeared; but the apoftle expreffes his thankfulnefs to God that the Theffalonians had efcaped this corruption. He exhorts them to ftedfaftnefs, and prays that God would comfort and ftrengthen them, (chap. ii.).

He requefts the prayers of the Theffalonians for him and his two affiftants, at the fame time expreffing his confidence that they would pay due regard to the inftructions which he had given them. He then proceeds to correct fome irregularities. Many of the Theffalonians feem to have led an idle diforderly life; thefe he feverely reproves, and commands the faithful to fhun their company if they ftill remained incorrigible.

209 Firft Epiftle to Timothy, when written.

When the firft Epiftle to Timothy was written, it is difficult to afcertain. Lardner dates it in 56; Mill, Whitby, and Macknight, place it in 64: but the arguments on which each party founds their opinion are too long to infert here.

210 Intention and contents of it.

Timothy was the intimate friend and companion of Paul, and is always mentioned by that apoftle with much affection and efteem. Having appointed him to fuperintend the church of Ephefus during a journey which he made to Macedonia, he wrote this letter, in order to direct him how to difcharge the important truft which was committed to him. This was the more neceffary, as Timothy was young and inexperienced, (1 Tim. iv. 12.). In the beginning of the epiftle he reminds him of the charge with which he had intrufted him, to wit, to preferve the purity of the gofpel againft the pernicious doctrines of the Judaizing teachers, whofe opinions led to frivolous controverfies, and not to a good life. He fhows the ufe of the law of Mofes, of which thefe teachers were ignorant. This account of the law, he affures Timothy, was agreeable to the reprefentation of it in the gofpel, with the preaching of which he was intrufted. He then makes a digreffion, in the fulnefs of his heart, to exprefs the fenfe which he felt of the goodnefs of God towards him.

In the fecond chapter, the apoftle prefcribes the manner in which the worfhip of God was to be performed in the church of Ephefus; and in the third explains the qualifications of the perfons whom he was to ordain as bifhops and deacons. In the fourth chapter he foretels the great corruptions of the church which were to prevail in future times, and inftructs him how to fupport the facred character. In the fifth chapter he teaches Timothy how to admonifh the old and young of both fexes; mentions the age and character of fuch widows as were to be employed by the fociety in fome peculiar office; and fubjoins fome things concerning the refpect due to elders. In the fixth chapter he defcribes the duties which Timothy was to inculcate on flaves; condemns trifling controverfies and pernicious difputes; cenfures the exceffive love of money, and charges the rich to be rich in good works. 211

Second Epiftle to Timothy.

That the fecond Epiftle to Timothy was written from Rome is univerfally agreed; but whether it was during his firft or fecond imprifonment has been much difputed. That Timothy was at Ephefus or in Afia Minor when this Epiftle was fent to him, appears from the frequent mention in it of perfons refiding at Ephefus. 212

Defign and contents of it.

The apoftle feems to have intended to prepare Timothy for thofe fufferings which he forefaw he would be expofed to. He exorts him to conftancy and perfeverance and to perform with a good confcience the duties of the facred function.

The falfe teachers, who had before thrown this church into confufion, grew every day worfe: infomuch that not only Hymenæus, but Philetus, another Ephefian heretic, now denied the refurrection of the dead. They were led into this error by a difpute about words. At firft they only annexed various improper fignifications to the word *refurrection*, but at laft they denied it altogether (H); pretending that the refurrection of the dead was only a refurrection from the death of fin, and fo

(G) For an explanation of this prophecy, Dr Hurd's Sermons may be confulted. He applies it to the papal power, to which it correfponds with aftonifhing exactnefs.

(H) This is by no means uncommon among men; to begin to difpute about the fignification of words, and to

Scripture. so was already past. This error was probably derived from the eastern philosophy, which placed the origin of sin in the body (chapter ii.). He then forewarns him of the fatal apostacy and declension that was beginning to appear in the church; and at the same time animates him, from his own example and the great motives of Christianity, to the most vigorous and resolute discharge of every part of the ministerial office.

213
Epistle to Titus.

This Epistle is addressed to Titus, whom Paul had appointed to preside over the church of Crete. It is difficult to determine either its date or the place from which it was sent. The apostle begins with reminding Titus of the reasons for which he had left him at Crete; and directs him on what principles he was to act in ordaining Christian pastors: the qualifications of whom he particularly describes. To show him how cautious he ought to be in selecting men for the sacred office, he reminds him of the arts of the Judaizing teachers, and the bad character of the Cretans (chapter i.).

214
Design and contents of it.

He advises him to accommodate his exhortations to the respective ages, sexes, and circumstances, of those whom it was his duty to instruct; and to give the greater weight to his instructions, he admonishes him to be an example of what he taught (chap. ii.). He exhorts him also to teach obedience to the civil magistrate, because the Judaizing Christians affirmed that no obedience was due from the worshippers of the true God to magistrates who were idolaters. He cautions against censoriousness and contention, and recommends meekness; for even the best Christians had formerly been wicked, and all the blessings which they enjoyed they derived from the goodness of God. He then enjoins Titus strenuously to inculcate good works, and to avoid useless controversies; and concludes with directing him how to proceed with those heretics who attempted to sow dissension in the church.

215
Epistle to Philemon.—Date and design of it.

The epistle to Philemon was written from Rome at the same time with the Epistles to the Colossians and Philippians, about A. D. 62 or 63. The occasion of the letter was this: Onesimus, Philemon's slave, had robbed his master and fled to Rome; where, happily for him, he met with the apostle, who was at that time a prisoner at large, and by his instructions and admonitions was converted to Christianity; and reclaimed to a sense of his duty. St Paul seems to have kept him for some considerable time under his eye, that he might be satisfied of the reality of the change; and, when he had made a sufficient trial of him, and found that his behaviour was entirely agreeable to his profession, he would not detain him any longer for his own private convenience, though in a situation that rendered such an assistant peculiarly desirable (compare ver. 13, 14.), but sent him back to his master; and, as a mark of his esteem, entrusted him, together with Tychicus, with the charge of delivering his Epistle to the church at Colosse, and giving them a particular account of the state of things at Rome, recommending him to them, at the same time, as a faithful and beloved brother (Col. iv. 9.).

Doddridge's Family Expositor.

And as Philemon might well be supposed to be strongly prejudiced against one who had left his service in so infamous a manner, he sends him this letter, in which he employs all his influence to remove his suspicions, and reconcile him to the thoughts of taking Onesimus into his family again. And whereas St Paul might have exerted that authority which his character as an apostle, and the relation in which he stood to Philemon as a spiritual father, would naturally give him, he chooses to entreat him as a friend; and with the softest and most insinuating address urges his suit, conjuring him by all the ties of Christian friendship that he would not deny him his request: and the more effectually to prevail upon him, he represents his own peace and happiness as deeply interested in the event; and speaks of Onesimus in such terms as were best adapted to soften his prejudices, and dispose him to receive one who was so dear to himself, not merely as a servant, but as a fellow Christian and a friend. Scripture.

216
The skill and address which the apostle discovers in this Epistle.

It is impossible to read over this admirable Epistle, without being touched with the delicacy of sentiment, and the masterly address that appear in every part of it. We see here, in a most striking light, how perfectly consistent true politeness is, not only with all the warmth and sincerity of the friend, but even with the dignity of the Christian and the apostle. And if this letter were to be considered in no other view than as a mere human composition, it must be allowed a master-piece in its kind. As an illustration of this remark, it may not be improper to compare it with an epistle of Pliny, that seems to have been written upon a similar occasion, (lib. ix. lit. 21); which, though penned by one that was reckoned to excel in the epistolary style, and though it has undoubtedly many beauties, yet must be acknowledged, by every impartial reader, vastly inferior to this animated composition of the apostle.

217
Epistle to the Hebrews was composed by Paul.

The epistle to the Hebrews has been generally ascribed to Paul; but the truth of this opinion has been suspected by others, for three reasons: 1. The name of the writer is nowhere mentioned, neither in the beginning nor in any other part of the Epistle. 2. The style is said to be more elegant than Paul's. 3. There are expressions in the Epistle which have been thought unsuitable to an apostle's character. 1. In answer to the first objection, Clemens Alexandrinus has assigned a very good reason: "Writing to the Hebrews (says he), who had conceived a prejudice against him, and were suspicious of him, he wisely declined setting his name at the beginning, lest he should offend them." 2. Origen and Jerome admired the elegance of the style, and reckoned it superior to that which Paul has exhibited in his Epistles: but as ancient testimony had assigned it to Paul, they endeavoured to answer the objection, by supposing that the sentiments were the apostle's, but the language and composition the work of some other person. If the Epistle, however, be a translation, which we believe it to be, the elegance of the language may belong to the translator. As to the composition and arrangement, it cannot be denied that there are many specimens in the writings of this apostle not inferior

Macknight on the Epistles.

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to be led gradually to deny the thing signified. This appears to have been the cause of most disputes, and the general beginning of scepticism and infidelity.

ferior in theſe qualities to the Epiſtle to the Hebrews. 3. It is objected, that in Heb. ii. 3. the writer of this Epiſtle joins himſelf with thoſe who had received the goſpel from Chriſt's apoſtles. Now Paul had it from Chriſt himſelf. But Paul often appeals to the teſtimony of the apoſtles in ſupport of thoſe truths which he had received from Revelation. We may inſtance 1 Cor. xv.
218 5, 6, 7, 8.; 2. Tim. ii. 2.

Quoted as his by ancient writers.

This Epiſtle is not quoted till the end of the ſecond century, and even then does not ſeem to have been univerſally received. This ſilence might be owing to the Hebrews themſelves, who ſuppoſing this letter had no relation to the Gentiles, might be at pains to diffuſe copies of it. The authors, however, on whoſe teſtimony we receive it as authentic, are entitled to credit; for they lived ſo near the age of the apoſtles, that they were in no danger of being impoſed on; and from the numerous liſt of books which they rejected as ſpurious, we are aſſured that they were very careful to guard againſt impoſition. It is often quoted as Paul's by Clemens Alexandrinus, about the year 194. It is received and quoted as Paul's by Origen, about 230; by Dionyſius biſhop of Alexandria in 247; and by a numerous liſt of ſucceeding writers.

219

Written in the Syro-Chaldaic language.

The Epiſtle to the Hebrews was originally written in Hebrew, or rather Syro-Chaldaic; a fact which we believe on the teſtimony of Clemens Alexandrinus, Jerome, and Euſebius. To this it has been objected, that as theſe writers have not referred to any authority, we ought to conſider what they ſay on this ſubject merely as an opinion. But as they ſtate no reaſons for adopting this opinion, but only mention as a fact that Paul wrote to the Hebrews in their native language, we muſt allow that it is their teſtimony which they produce, and not their opinion. Euſebius informs us, that ſome ſuppoſed Luke the Evangeliſt, and others Clemens Romanus, to have been the tranſlator.

According to the opinion of ancient writers, particularly Clemens Alexandrinus, Jerome, and Euthalius, this Epiſtle was addreſſed to the Jews in Paleſtine.—The
220 ſcope of the Epiſtle confirms this opinion.

Date of it.

Having now given ſufficient evidence that this Epiſtle was written by Paul, the time when it was written may be eaſily determined: For the ſalutation from the ſaints of Italy (chap. iv. 24.), together with the apoſtle's promiſe to ſee the Hebrews (ver. 23.), plainly intimate, that his confinement was then either ended or on the eve of being ended. It muſt therefore have been written ſoon after the Epiſtles to the Coloſſians, Epheſians, and Philemon, and not long before Paul left Italy, that is, in the year 61 or 62.

Percy's Key to the New Teſtament.

As the zealous defenders of the Moſaic law would naturally inſiſt on the divine authority of Moſes, on the majeſty and glory attending its promulgation by the miniſtry of angels, and the great privileges it afforded thoſe who adhered to it; the apoſtle ſhows,

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Deſign of it to prove to the Jews the truth of the Chriſtian religion and its ſuperiority to the law of Moſes;

I. That in all theſe ſeveral articles Chriſtianity had an infinite ſuperiority to the law.

This topic he purſues from chap. i. to xi. wherein he reminds the believing Hebrews of the extraordinary favour ſhown them by God, in ſending them a revelation by his own ſon, whoſe glory was far ſuperior to that of angels (chap. i. throughout); very naturally inferring from hence the danger of deſpiſing Chriſt on account of his humilitation, which, in perfect conſiſtence with his dominion over the world to come, was voluntarily ſubmitted to by him for wiſe and important reaſons; particularly to deliver us from the fear of death, and to encourage the freedom of our acceſs to God (chap. ii. throughout). With the ſame view he magnifies Chriſt as ſuperior to Moſes, their great legiſlator; and from the puniſhment inflicted on thoſe who rebelled againſt the authority of Moſes, infers the danger of contemning the promiſes of the goſpel (chap. iii. 2—13.). And as it was an eaſy tranſition to call to mind on this occaſion that reſt in Canaan to which the authority inveſted in Moſes was intended to lead them; the apoſtle hence cautions them againſt unbelief, as what would prevent their entering into a ſuperior ſtate of reſt to what the Jews ever enjoyed (chap. iii. 14. iv. 11.). This caution is ſtill farther enforced by awful views of God's omniſcience, and a lively repreſentation of the high-prieſthood of Chriſt (chap. iv. to the end; and chap. v. throughout). In the next place, he intimates the very hopeleſs ſituation of thoſe who apoſtatiſe from Chriſtianity (chap. vi. 1—9.); and then, for the comfort and confirmation of ſincere believers, diſplays to them the goodneſs of God, and his faithful adherence to his holy engagements; the performance of which is ſealed by the entrance of Chriſt into heaven as our forerunner (chap. vi. 9. to the end). Still farther to illuſtrate the character of our Lord, he enters into a parallel between him and Melchizedec as to their title and deſcent; and, from inſtances wherein the prieſthood of Melchizedec excelled the Levitical, infers, that the glory of the prieſthood of Chriſt ſurpaſſed that under the law (chap. vii. 1—17). From theſe premiſes the apoſtle argues, that the Aaronical prieſthood was not only excelled, but conſummated by that of Chriſt, to which it was only introductory and ſubſervient; and of courſe, that the obligation of the law was henceforth diſſolved (chap. vii. 18. to the end). Then recapitulating what he had already demonſtrated concerning the ſuperior dignity of Chriſt's prieſthood, he thence illuſtrates the diſtinguiſhed excellence of the new covenant, as not only foretold by Jeremiah, but evidently enriched with much better promiſes than the old (ch. viii. throughout): Explaining farther the doctrine of the prieſthood and interceſſion of Chriſt, by comparing it with what the Jewiſh high-prieſts did on the great day of atonement (chap. ix. 1—14). Afterwards he enlarges on the neceſſity of ſhedding Chriſt's blood, and the ſufficiency of the atonement made by it (chap. ix. 15. to the end); and proves that the legal ceremonies could not by any means purify the conſcience: whence he infers the inſufficiency of the Moſaic law, and the neceſſity of looking beyond it (chap. x. 1—15.). He then urges the Hebrews to improve the privileges which ſuch an high-prieſt and covenant conferred on them, to the purpoſes of approaching God with confidence, to a conſtant attendance on his worſhip, and moſt benevolent regards to each other (chap. x. 15—25.).

The apoſtle having thus obviated the inſinuations and objections of the Jews, for the ſatisfaction and eſtabliſhment of the believing Hebrews, proceeds, 222

and to animate them to bear perſecution with fortitude.

II. To prepare and fortify their minds againſt the ſtorm of perſecution which in part had already befallen them, which was likely to continue and be often renewed, he reminds them of thoſe extremities they had endured, and of the fatal effects which would attend their apoſtacy

apoſtacy (chap. x. 26. to the end); calling to their remembrance the eminent examples of faith and fortitude exhibited by holy men, and recorded in the Old Teſtament (chap. xi. 1—29.). He concludes his diſcourſe with glancing at many other illuſtrious worthies; and, beſides thoſe recorded in Scripture, refers to the caſe of ſeveral who ſuffered under the perſecution of Antiochus Epiphanes (2 Maccab. chap. viii. &c. chap. xi. 30. xii. 2.).

Having thus finiſhed the argumentative part of the Epiſtle, the apoſtle proceeds to a general application; in which he exhorts the Hebrew Chriſtians to patience, peace, and holineſs (chap. xii. 3—14.); cautions them againſt ſecular views and ſenſual gratifications, by laying before them the incomparable excellence of the bleſſings introduced by the goſpel, which even the Jewiſh economy, glorious and magnificent as it was, did by no means equal; exhorts them to brotherly affection, purity, compaſſion, dependence on the divine care, ſtedfaſtneſs in the profeſſion of truth, a life of thankfulneſs to God, and benevolence to man: and concludes the whole with recommending their pious miniſters to their particular regard, intreating their prayers, ſaluting and granting them his uſual benediction.

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The ſeven Catholic epiſtles.

The ſeven following Epiſtles, one of James, two of Peter, three of John, and one of Jude, have been diſtinguiſhed by the appellation of *catholic* or *general* epiſtles, becauſe moſt of them are inſcribed, not to particular churches or perſons, but to the body of Jewiſh or Gentile converts over the world. The authenticity of ſome of theſe has been frequently queſtioned, viz. the Epiſtle of James, the ſecond of Peter, the Epiſtle of Jude, and the ſecond and third of John. The ancient Chriſtians were very cautious in admitting any books into their canon whoſe authenticity they had any reaſon to ſuſpect. They rejected all the writings forged by heretics in the name of the apoſtles, and certainly, therefore, would not receive any without firſt ſubjecting them to a ſevere ſcrutiny. Now, though theſe five epiſtles were not immediately acknowledged as the writings of the apoſtles, this only ſhows that the perſons who doubted had not received complete and inconteſtable evidence of their authenticity. But as they were afterwards univerſally received, we have every reaſon to conclude, that upon a ſtrict examination they were found to be the genuine productions of the apoſtles. The truth is, ſo good an opportunity had the ancient Chriſtians of examining this matter, ſo careful were they to guard againſt impoſition, and ſo well founded was their judgement concerning the books of the New Teſtament, that, as Dr Lardner obſerves, no writing which they pronounced genuine has yet been proved ſpurious, nor have we at this day the leaſt reaſon to believe any book genuine which they rejected.

Macknight on the Epiſtles.

224
Epiſtle of James the Leſs.

That the Epiſtle of James was written in the apoſtolical age is proved by the quotations of ancient authors. Clemens Romanus and Ignatius ſeem to have made references to it. Origen quotes it once or twice.—There are ſeveral reaſons why it was not more generally quoted by the firſt Chriſtian writers. Being written to correct the errors and vices which prevailed among the Jews, the Gentiles might think it of leſs importance to them, and therefore take no pains to procure copies of it. As the author was ſometimes denominated James the Juſt, and often called biſhop of Jeruſalem, it might be doubted whether he was one of the apoſtles. But its authenticity does not ſeem to have been ſuſpected on account of the doctrines which it contains. In modern times, indeed, Luther called it a ſtrawy epiſtle (*epiſtola ſtraminea*), and excluded it from the ſacred writings, on account of its apparent oppoſition to the apoſtle Paul concerning juſtification by faith.

This Epiſtle could not be written by James the Elder, the ſon of Zebedee, and brother of John, who was beheaded by Herod in the year 44, for it contains paſſages which refer to a later period. It muſt, therefore, have been the compoſition of James the Leſs, the ſon of Alpheus, who was called *the Lord's brother*, becauſe he was the ſon of Mary, the ſiſter of our Lord's mother. 225
As to the date of this Epiſtle, Lardner fixes it in the year 61 or 62.

The date

James the Leſs ſtatedly reſided at Jeruſalem, whence he hath been ſtyled by ſome ancient fathers biſhop of that city, though without ſufficient foundation. Now James being one of the apoſtles of the circumciſion, while he confined his perſonal labours to the inhabitants of Judea, it was very natural for him to endeavour by his writings to extend his ſervices to the Jewiſh Chriſtians who were diſperſed abroad in more diſtant regions. For this purpoſe, there are two points which the apoſtle ſeems to have principally aimed at, though he hath not purſued them in an orderly and logical method, but in the free epiſtolary manner, handling them jointly or diſtinctly as occaſions naturally offered. And theſe were, "to correct thoſe errors both in doctrine and practice into which the Jewiſh Chriſtians had fallen, which might otherwiſe have produced fatal conſequences; and then to eſtabliſh the faith and animate the hope of ſincere believers, both under their preſent and their approaching ſufferings."

Doddridge's Family Expoſitor.

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and deſign of it.

The opinions which he is moſt anxious to refute are theſe, that God is the author of ſin, (ch. i. 13.); that the belief of the doctrines of the goſpel was ſufficient to procure the favour of God for them, however deficient they were in good works, (ch. ii.). He diſſuades the Jews from aſpiring to the office of teachers in the third chapter, becauſe their prejudices in favour of the law of Moſes might induce them to pervert the doctrines of the goſpel. He therefore guards them againſt the ſins of the tongue, by repreſenting their pernicious effects; and as they thought themſelves wiſe and intelligent, and were ambitious of becoming teachers, he adviſes them to make good their pretenſions, by ſhowing themſelves poſſeſſed of that wiſdom which is from above, (ch. iii.).

The deſtruction of Jeruſalem was now approaching; the Jews were ſplit into factions, and often ſlaughtered one another; the apoſtle, therefore, in the fourth chapter, admoniſhes them to purify themſelves from thoſe vices which produced tumults and bloodſhed. To rouſe them to repentance, he foretels the miſeries that were coming upon them. Laſtly, He checks an irreligious ſpirit that ſeems to have prevailed, and concludes the Epiſtle with ſeveral exhortations.

227
Firſt Epiſtle of Peter.

The authenticity of the firſt Epiſtle of Peter has never been denied. It is referred to by Clemens Romanus, by Polycarp, and is quoted by Papias, Irenæus, Clemens Alexandrinus, and Tertullian. It is addreſſed to the ſtrangers ſcattered through Pontus, &c. who are evidently Chriſtians in general, as appears from chap.

Scripture. chap. ii. 10. "In time past they were not a people, but are now the people of God." From Peter's sending the salutation of the church at Babylon to the Christians in Pontus, &c. it is generally believed that he wrote it in Babylon. There was a Babylon in Egypt and another in Assyria. It could not be the former, for it was an obscure place, which seems to have had no church for the first four centuries. We have no authority to affirm that Peter ever was in Assyria. The most probable opinion is that of Grotius, Whitby, Lardner, as well as of Eusebius, Jerome, and others, that by Babylon Peter figuratively means Rome.

228 The date Lardner dates it in 63 or 64, or at the latest 65.

229 and design of it. St Peter's chief design is to confirm the doctrine of St Paul, which the false teachers pretended he was opposing; and to assure the proselytes that they stood in the true grace of God, (ch. v. 12.). With this view he calls them elect; and mentions, that they had been declared such by the effusion of the Holy Ghost upon them, (ch. i. 1, 2.). He assures them that they were regenerate without circumcision, merely through the gospel and resurrection of Christ, (ver. 3, 4, 21—25.); and that their sufferings were no argument of their being under the displeasure of God, as the Jews imagined, (ver. 6—12.). He recommends it to them to hope for grace to the end, (ver. 13.). He testifies, that they were not redeemed by the Paschal lamb, but through Christ, whom God had preordained for this purpose before the foundation of the world, (ver. 18—20.).

230 Second Epistle of Peter. The authenticity of it proved The second Epistle of Peter is not mentioned by any ancient writer extant till the fourth century, from which time it has been received by all Christians except the Syrians. Jerome acquaints us, that its authenticity was disputed, on account of a remarkable difference between the style of it and the former Epistle. But this remarkable difference in style is confined to the 2d chapter of the 2d Epistle. No objection, however, can be drawn from this circumstance; for the subject of that chapter is different from the rest of Peter's writings, and nothing is so well known than that different subjects suggest different styles. Peter, in describing the character of some flagitious impostors, feels an indignation which he cannot suppress: it breaks out, therefore, in the bold and animated figures of an oriental writer. Such a diversity of style is not uncommon in the best writers, especially when warmed with their subject.

231 from internal evidence. This objection being removed, we contend that this Epistle was written by Peter, from the inscription, *Simon Peter, a servant and an apostle of Jesus Christ.* It appears from chap. i. 16, 17, 18, that the writer was one of the disciples who saw the transfiguration of our Saviour. Since it has never been ascribed to James or John, it must therefore have been Peter. It is evident, from chap. iii. 1. that the author had written an Epistle before to the same persons, which is another circumstance that proves Peter to be the author.

It is acknowledged, however, that all this evidence is merely internal; for we have not been able to find any external evidence upon the subject. If, therefore, the credit which we give to any fact is to be in proportion to the degree of evidence with which it is accompanied, we shall allow more authority due to the gospels than to the epistles; more to those epistles which have been generally acknowledged than to those which have been controverted; and therefore no doctrine of Christianity ought to be founded solely upon them. It may also be added, that perhaps the best way of determining what are the essential doctrines of Christianity would be to examine what are the doctrines which occur oftenest in the gospels; for the gospels are the plainest parts of the New Testament; and their authenticity is most completely proved. They are therefore best fitted for common readers. Nor will it be denied, we presume, that our Saviour taught all the doctrines of the Christian religion himself; that he repeated them on different occasions, and inculcated them with an earnestness proportionable to their importance. The Epistles are to be considered as a commentary on the essential doctrines of the gospel, adapted to the situation and circumstances of particular churches, and perhaps sometimes explaining doctrines of inferior importance. 1. The essential doctrines are therefore first to be sought for in the gospels, and to be determined by the number of times they occur. 2. They are to be sought for, in the next place, in the uncontroverted Epistles, in the same manner. 3. No essential doctrine ought to be founded on a single passage, nor on the authority of a controverted Epistle.

That Peter was old, and near his end, when he wrote this Epistle, may be inferred from chap. i. 14. "Knowing that shortly I must put off this tabernacle, even as our Lord Jesus has shewn me." Lardner thinks it was written soon after the former. Others, perhaps with more accuracy, date it in 67.

The general design of this Epistle is, to confirm the doctrines and instructions delivered in the former; "to excite the Christian converts to adorn, and stedfastly adhere to their holy religion, as a religion proceeding from God, notwithstanding the artifices of false teachers, whose character is at large described; or the persecution of their bitter and inveterate enemies." 232 Design of it.

The first Epistle of John is ascribed by the unanimous suffrage of the ancients to the beloved disciple of our Lord. It is referred to by Polycarp, is quoted by Papias, by Irenæus, and was received as genuine by Clemens Alexandrinus, by Dionysius of Alexandria, by Cyprian, by Origen, and Eusebius. There is such a resemblance between the style and sentiments of this Epistle and those of the gospel according to John, as to afford the highest degree of internal evidence that they are the composition of the same author. In the style of this apostle there is a remarkable peculiarity, and especially in this Epistle. His sentences, considered separately, are exceeding clear and intelligible; but when we search for their connection, we frequently meet with greater difficulties than we do even in the Epistles of St Paul. The principal signature and characteristic of his manner is an artless and amiable simplicity, and a singular modesty and candour, in conjunction with a wonderful sublimity of sentiment. His conceptions are apparently delivered to us in the order in which they arose to his own mind, and are not the product of artificial reasoning or laboured investigation. 233 First Epistle of John. Its authenticity and style.

It is impossible to fix with any precision the *date* of this Epistle, nor can we determine to what persons it was addressed.

The leading design of the apostle is to show the insufficiency of faith, and the external profession of religion, separate from morality; to guard the Christians to whom he writes against the delusive arts of the corrupters 234 Design of it.

Scripture. rupters of Chriſtianity, whom he calls Antichriſt; and to inculcate univerſal benevolence. His admonitions concerning the neceſſity of good morals, and the inefficacy of external profeſſions, are ſcattered over the Epiſtle, but are moſt frequent in the 1ſt, 2d, and 3d chapters. The enemies or corrupters of Chriſtianity, againſt whom he contends, ſeem to have denied that Jeſus was the Meſſiah, the Son of God (chap. ii. 22. v. 1.), and had actually come into the world in a human form, (chap. iv. 2, 3.). The earneſtneſs and frequency with which this apoſtle recommends the duty of benevolence is remarkable. He makes it the diſtinguiſhing characteriſtic of the diſciples of Jeſus, the only ſure pledge of our love to God, and the only aſſurance of eternal life, (chap. iii. 34, 15.). Benevolence was his favourite theme, which he affectionately preſſed upon others, and conſtantly practiſed himſelf. It was conſpicuous in his conduct to his great Maſter, and in the reciprocal affection which it inſpired in his ſacred breaſt. He continued to recommend it in his laſt words. When his extreme age and infirmities had ſo waſted his ſtrength that he was incapable to exerciſe the duties of his office, the venerable old man, anxious to exert in the ſervice of his Maſter the little ſtrength which ſtill remained, cauſed himſelf to be carried to church, and, in the midſt of the congregation, he repeated theſe words, "Little children, love one another."

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econd and third Epiſtles of John. It has been obſerved by Dr Mill that the ſecond and third Epiſtles of John are ſo ſhort, and reſemble the firſt ſo much in ſentiment and ſtyle, that it is not worth while to contend about them. The ſecond Epiſtle conſiſts only of 13 verſes; and of theſe eight may be found in the 1ſt Epiſtle, in which the ſenſe or language is preciſely the ſame.

The ſecond Epiſtle is quoted by Irenæus, and was received by Clemens Alexandrinus. Both were admitted by Athanaſius, by Cyril of Jeruſalem, and by Jerome. The ſecond is addreſſed to a woman of diſtinction whoſe name is by ſome ſuppoſed to be *Cyria* (taking κυρια for a proper name), by others *Electa*. The third is inſcribed to Gaius, or Caius according to the Latin orthography, who, in the opinion of Lardner, was an eminent Chriſtian, that lived in ſome city of Aſia not far from Epheſus, where St John chiefly reſided after his leaving Judea. The time of writing theſe two Epiſtles cannot be determined with any certainty. They are ſo ſhort that an analyſis of them is not neceſſary.

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piſtle of ide. Its uthenticity. The Epiſtle of Jude is cited by no ancient Chriſtian writer extant before Clemens Alexandrinus about the year 194; but this author has tranſcribed eight or ten verſes in his Stromata and Pedagogue. It is quoted once by Tertullian about the year 200; by Origen frequently about 230. It was not however received by many of the ancient Chriſtians, on account of a ſuppoſed quotation from a book of Enoch. But it is not certain that Jude quotes any book. He only ſays that *Enoch propheſied, ſaying, The Lord cometh with ten thouſand of his ſaints.* Theſe might be words of a prophecy preſerved by tradition, and inſerted occaſionally in different writings. Nor is there any evidence that there was ſuch a book as Enoch's prophecies in the time of Jude, though a book of that name was extant in the ſecond and third centuries. As to the date of this Epiſtle nothing beyond conjecture can be produced. Scripture.

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The deſign of it is, by deſcribing the character of the falſe teachers, and the puniſhments to which they were liable, to caution Chriſtians againſt liſtening to their ſuggeſtions, and being thereby perverted from the faith and purity of the goſpel. and deſign.

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The Apocalypſe or Revelation has not always been unanimouſly received as the genuine production of the apoſtle John. Its authenticity is proved, however, by the teſtimony of many reſpectable authors of the firſt centuries. It is referred to by the martyrs of Lyons: it was admitted by Juſtin Martyr as the work of the apoſtle John. It is often quoted by Irenæus, by Theophilus biſhop of Antioch, by Clement of Alexandria, by Tertullian, by Origen, and by Cyprian of Carthage. It was alſo received by heretics, by Novatus and his followers, by the Donatiſts, and by the Arians. For the firſt two centuries no part of the New Teſtament was more univerſally acknowledged, or mentioned with higher reſpect. But a diſpute having ariſen about the millennium, Caius with ſome others, about the year 212, to end the controverſy as ſpeedily and effectually as poſſible, ventured to deny the authority of the book which had given occaſion to it. The Apocalypſe. Its authenticity proved.

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The book of Revelation, as we learn from Rev. i. 9. was written in the iſle of Patmos. According to the general teſtimony of ancient authors, John was baniſhed into Patmos in the reign of Domitian, and reſtored by his ſucceſſor Nerva. But the book could not be publiſhed till after John's releaſe, when he returned to Epheſus. As Domitian died in 96, and his perſecution did not commence till near the end of his reign, the Revelation might therefore be publiſhed in 96 or 97. The date of it.

Here we ſhould conclude; but as the curious reader may deſire to be informed how the predictions revealed in this book of St John have uſually been interpreted and applied, we ſhall conſiſtently with our ſubject ſubjoin *a key to the prophecies contained in the Revelation.* This is extracted from the learned diſſertations of Dr Newton, biſhop of Briſtol (1): to which the reader is referred for a more full illuſtration of the ſeveral parts, as the conciſeneſs of our plan only admits a ſhort analyſis or abridgment of them. *Percy's Key to the New Teſtament.*

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Nothing of a prophetical nature occurs in the firſt three chapters, except, 1. What is ſaid concerning the church of Epheſus, that her "candleſtick ſhall be removed out of its place," which is now verified, not only in this, but in all the other Aſiatic churches which exiſted at that time; the light of the goſpel having been taken from them, not only by their hereſies and diviſions from within, but by the arms of the Saracens from without: And, 2. Concerning the church of Smyrna, that ſhe ſhall "have tribulation ten days;" that is, in prophetic language, Dr Newton's explication of the prophecies which have been already accompliſhed.

(1) Diſſertations on the prophecies which have remarkably been fulfilled, and at this time are fulfilling, in the world, vol. iii. 8vo.

guage, "ten years;" referring to the perſecution of Diocleſian, which alone of all the general perſecutions laſted ſo long.

The next five chapters relate to the opening of the *Seven Seals;* and by theſe ſeals are intimated ſo many different periods of the prophecy. Six of theſe ſeals are opened in the ſixth and ſeventh chapters.

The *firſt ſeal* or period is memorable for conqueſts. It commences with Veſpaſian, and terminates in Nerva; and during this time Judea was ſubjugated. The *ſecond ſeal* is noted for war and ſlaughter. It commences with Trajan, and continues through his reign, and that of his ſucceſſors. In this period, the Jews were entirely routed and diſperſed; and great was the ſlaughter and devaſtation occaſioned by the contending parties. The *third ſeal* is characteriſed by a rigorous execution of juſtice, and an abundant proviſion of corn, wine, and oil. It commences with Septimius Severus. He and Alexander Severus were juſt and ſevere emperors, and at the ſame time highly celebrated for the regard they paid to the felicity of their people, by procuring them plenty of every thing, and particularly corn, wine, and oil. This period laſted during the reigns of the Septimian family. The *fourth ſeal* is diſtinguiſhed by a concurrence of evils, ſuch as war, famine, peſtilence, and wild beaſts; by all which the Roman empire was remarkably infeſted from the reign of Maximin to that of Diocleſian. The *fifth ſeal* begins at Diocleſian, and is ſignalized by the great perſecution, from whence aroſe that memorable era, the Era of Martyrs. With Conſtantine begins the *ſixth ſeal*, a period of revolutions, pictured forth by great commotions in earth and in heaven, alluding to the ſubverſion of Paganiſm and the eſtabliſhment of Chriſtianity. This period laſted from the reign of Conſtantine the Great to that of Theodoſius the firſt. The *ſeventh ſeal* includes under it the remaining parts of the prophecy, and comprehends ſeven periods diſtinguiſhed by the ſounding of ſeven trumpets.

As the ſeals foretold the ſtate of the Roman empire before and till it became Chriſtian, ſo the trumpets foreſhow the fate of it afterwards; each trumpet being an alarm to one nation or other, rouſing them up to overthrow that empire.

Four of theſe trumpets are ſounded in the eighth chapter.

At the ſounding of the firſt, Alaric and his Goths invade the Roman empire, beſiege Rome twice, and ſet it on fire in ſeveral places. At the ſounding of the ſecond, Attila and his Huns waſte the Roman provinces, and compel the eaſtern emperor Theodoſius the ſecond, and the weſtern emperor Valentinian the third, to ſubmit to ſhameful terms. At the ſounding of the third, Genſeric and his Vandals arrive from Africa; ſpoil and plunder Rome, and ſet ſail again with immenſe wealth and innumerable captives. At the ſounding of the fourth, Odoacer and the Heruli put an end to the very name of the weſtern empire; Theodoric founds the kingdom of the Oſtrogoths in Italy; and at laſt Italy becomes a province of the eaſtern empire, Rome being governed by a duke under the exarch of Ravenna. As the foregoing trumpets relate chiefly to the downfal of the weſtern empire, ſo do the following to that of the eaſtern. They are ſounded in the ninth, tenth, and part of the eleventh chapters. At the ſounding of the fifth trumpet, Mahomet, that blazing ſtar, appears, opens the bottomleſs pit, and with his locuſts the Arabians darkens the ſun and air. And at the ſounding of the ſixth, a period not yet finiſhed, the four angels, that is, the four ſultans, or leaders of the Turks and Othmans, are looſed from the river Euphrates. The Greek or Eaſtern empire was cruelly "hurt and tormented" under the fifth trumpet; but under the ſixth, was "ſlain," and utterly deſtroyed.

The Latin or Weſtern Church not being reclaimed by the ruin of the Greek or Eaſtern, but ſtill perſiſting in their idolatry and wickedneſs; at the beginning of the tenth chapter, and under the ſound of this ſixth trumpet, is introduced a viſion preparative to the prophecies reſpecting the Weſtern Church, wherein an angel is repreſented, having in his hand a little book, or codicil, deſcribing the calamities that ſhould overtake that church. The meaſuring of the temple ſhows, that during all this period there will be ſome true Chriſtians, who will conform themſelves to the rule of God's word, even whilſt the outer court, that is, the external and more extenſive part of this temple or church, is trodden under foot by Gentiles, *i. e.* ſuch Chriſtians as, in their idolatrous worſhip and perſecuting practice, reſemble and outdo the Gentiles themſelves. Yet againſt theſe corrupters of religion there will always be ſome true witneſſes to proteſt, who, however they may be overborne at times, and in appearance reduced to death, yet will ariſe again from time to time, till at laſt they triumph and glorioſly aſcend. The eleventh chapter concludes with the ſounding of the ſeventh trumpet.

In the twelfth chapter, by the woman bearing a man-child is to be underſtood the Chriſtian church; by the great red dragon, the heathen Roman empire; by the man-child whom the woman bore, Conſtantine the Great; and by the war in heaven, the conteſts between the Chriſtian and Heathen religions.

In the thirteenth chapter, by the beaſt with ſeven heads and ten horns, unto whom the dragon gave his power, ſeat, and great authority, is to be underſtood, not Pagan but Chriſtian, not imperial but papal Rome; in ſubmitting to whoſe religion, the world did in effect ſubmit again to the religion of the dragon. The ten-horned beaſt therefore repreſents the Romiſh church and ſtate in general: but the beaſt with two horns like a lamb is the Roman clergy; and that image of the ten-horned beaſt, which the two-horned beaſt cauſed to be made, and inſpired with life, is the pope; whoſe number is 666, according to the numerical powers of the letters conſtituting the Roman name Λατεινος, *Latinus*, or its equivalent in *Hebrew*, רומיית *Romith*.

Λ	30	200	ר
Α	1	6	ו
Τ	300	40	מ
Ε	5	10	י
Ι	10	10	י
Ν	50	400	ת
Ο	70		
Σ	200		
	666	666	

Chapter xiv. By the lamb on Mount Sion is meant Jeſus; by the hundred forty and four thouſand, his church and followers; by the angel preaching the everlaſting lafting gofpel, the firft principal effort made towards a reformation by that public oppofition formed againft the worfhip of faints and images by emperors and bifhops in the eighth and ninth centuries; by the angel crying, "Babylon is fallen," the Waldenfes and Albigenfes, who pronounced the church of Rome to be the Apocalyptic Babylon, and denounced her deftruction; and by the third angel Martin Luther and his fellow reformers, who protefted againft all the corruptions of the church of Rome, as deftructive to falvation. For an account of the doctrines and precepts contained in the Scriptures, fee THEOLOGY. For proofs of their divine origin, fee RELIGION, PROPHECY, and MIRACLES.

SCRIVENER, one who draws contracts, or whofe bufinefs it is to place money at intereft. If a fcrivener be entrufted with a bond, he may receive the intereft; and if he fail, the obligee fhall bear the lofs: and fo it is if he receive the principal and deliver up the bond; for being entrufted with the fecurity itfelf, it muft be prefumed that he is trufted with power to receive intereft or principal; and the giving up the bond on payment of the money fhall be a difcharge thereof. But if a fcrivener fhall be entrufted with a mortgage-deed, he hath only authority to receive the intereft, not the principal; the giving up the deed in this cafe not being fufficient to reftore the eftate, but there muft be a reconveyance, &c. It is held, where a fcrivener puts out his client's money on a bad fecurity, which upon inquiry might have been eafily found fo, yet he cannot in equity be charged to anfwer for the money; for it is here faid, no one would venture to put out money of another upon a fecurity, if he were obliged to warrant and make it good in cafe a lofs fhould happen, without any fraud in him.

SCROBICULUS CORDIS, the fame as ANTICARDIUM.

SCROFANELLO, in *Ichthyology*, a name by which fome have called a fmall fifh of the Mediterranean, more ufually known by the name of the *fcorpæna*.

SCROLL, in *Heraldry*. See that article, chap. iv. fect. 9. When the motto relates to the creft, the fcroll is properly placed above the achievement; otherwife it fhould be annexed to the efcutcheon. Thofe of the order of knighthood are generally placed round fhields.

SCROPHULA, the KING'S EVIL. See MEDICINE, N° 349.

SCROPHULARIA, FIGWORT, a genus of plants belonging to the didynamia clafs, and in the natural method ranking under the 40th order, *Perfonatæ*. See BOTANY *Index*.

SCROTUM. See ANATOMY, N° 220.

SCRUPLE, SCRUPULUS, or *Scrupulum*, the leaft of the weights ufed by the ancients, which amongft the Romans was the 24th part of an ounce, or the 3d part of a dram. The fcruple is ftill a weight among us, containing the 3d part of a dram, or 20 grains. Among goldfmiths it is 24 grains.

SCRUPLE, in *Chaldean Chronology*, is $\frac{1}{1080}$ part of an hour, called by the Hebrews *helakin*. Thefe fcruples are much ufed by the Jews, Arabs, and other eaftern people, in computations of time.

SCRUPLES of half Duration, an arch of the moon's orbit, which the moon's centre defcribes from the beginning of an eclipfe to its middle.

SCRUPLES of Immerfion or *Incidence*, an arch of the moon's orbit, which her centre defcribes from the beginning of the eclipfe to the time when its centre falls into the fhadow.

SCRUPLES of Emerfion, an arch of the moon's orbit, which her centre defcribes in the time from the firft emerfion of the moon's limb to the end of the eclipfe.

SCRUTINY, (*Scrutinium*), in the primitive church, an examination or probation practifed in the laft week of Lent, on the catechumens, who were to receive baptifm on the Eafter-day. The fcrutiny was performed with a great many ceremonies. Exorcifms and prayers were made over the heads of the catechumens; and on Palm Sunday, the Lord's Prayer and Creed were given them, which they were afterwards made to rehearfe. This cuftom was more in ufe in the church of Rome than anywhere elfe; though it appears, by fome miffals, to have been likewife ufed, though much later, in the Gallican church. It is fuppofed to have ceafed about the year 860. Some traces of this practice ftill remain at Vienne, in Dauphiné, and at Liege.

SCRUTINY, is alfo ufed, in the *Canon Law*, for a ticket or little paper billet, wherein at elections the electors write their votes privately, fo as it may not be known for whom they vote. Among us the term *fcrutiny* is chiefly ufed for a ftrict perufal and examination of the feveral votes haftily taken at an election; in order to find out any irregularities committed therein, by unqualified voters, &c.

SCRUTORE, or SCRUTOIR (from the French *efcritoire*), a kind of cabinet, with a door or lid opening downwards, for conveniency of writing on, &c.

SCRY, in falconry, denotes a large flock of fowl.

SCUDDING, the movement by which a fhip is carried precipitately before a tempeft. As a fhip flies with amazing rapidity through the water whenever this expedient is put in practice, it is never attempted in a contrary wind, unlefs when her condition renders her incapable of fuftaining the mutual effort of the wind and waves any longer on her fide, without being expofed to the moft imminent danger of being overfet.

A fhip either fcuds with a fail extended on her foremaft, or, if the ftorm is exceffive, without any fail: which, in the fea-phrafe, is called *fcudding under bare poles*. In floops and fchooners, and other fmall veffels, the fail employed for this purpofe is called the *fquare fail*. In large fhips, it is either the forefail at large, reefed, or with its goofe-wings extended, according to the degree of the tempeft; or it is the fore-top fail, clofe reefed, and lowered on the cap; which laft is particularly ufed when the fea runs fo high as to becalm the forefail occafionally, a circumftance which expofes the fhip to the danger of broaching to. The principal hazards incident to fcudding are generally, a pooping fea; the difficulty of fteering, which expofes the veffel perpetually to the rifk of broaching to; and the want of fufficient fea-room. A fea ftriking the fhip violently on the ftern may dafh it inwards, by which fhe muft inevitably founder. In broaching to (that is, inclining fuddenly to windward), fhe is threatened with being immediately overturned; and, for want of fea-room, fhe is endangered

dangered by ſhipwreck on a lee-ſhore, a circumſtance too dreadful to require explanation.

SCULPONEÆ, among the Romans, a kind of ſhoes worn by ſlaves of both ſexes. Theſe ſhoes were only blocks of wood made hollow, like the French ſabots.

SCULPTURE,

1 Definition of ſculpture. Origin of it.

IS the art of carving wood or hewing ſtone into images. It is an art of the moſt remote antiquity, being practiſed, as there is reaſon to believe, before the general deluge. We are induced to aſſign to it this early origin, by conſidering the expedients by which, in the firſt ſtages of ſociety, men have everywhere ſupplied the place of alphabetic characters. Theſe, it is univerſally known, have been picture-writing, ſuch as that of the Mexicans, which, in the progreſs of refinement and knowledge, was gradually improved into the hieroglyphics of the Egyptians and other ancient nations. See HIEROGLYPHICS.

That mankind ſhould have lived near 1700 years, from the creation of the world to the flood of Noah, without falling upon any method to make their conceptions permanent, or to communicate them to a diſtance, is extremely improbable; eſpecially when we call to mind that ſuch methods of writing have been found, in modern times, among people much leſs enlightened than thoſe muſt have been who were capable of building ſuch a veſſel as the ark. But if the antediluvians were acquainted with any kind of writing, there can be little doubt of its being hieroglyphical writing. Mr Bryant has proved that the Chaldeans were poſſeſſed of that art before the Egyptians; and Beroſus * informs us, that a delineation of all the monſtrous forms which inhabited the chaos, when this earth was in that ſtate, was to be ſeen in the temple of Belus in Babylon. This delineation, as he deſcribes it, muſt have been a hiſtory in hieroglyphical characters; for it conſiſted of human figures with wings, with two heads, and ſome with the horns and legs of goats. This is exactly ſimilar to the hieroglyphical writing of the Egyptians; and it was preſerved, our author ſays, both in drawings and *engravings* in the temple of the god of Babylon. As Chaldee was the firſt peopled region of the earth after the flood, and as it appears from Pliny †, as well as from Beroſus, that the art of engraving on bricks baked in the ſun was there carried to a conſiderable degree of perfection at a very early period, the probability certainly is, that the Chaldeans derived the art of hieroglyphical writing, and conſequently the rudiments of the art of ſculpture, from their antediluvian anceſtors.

* *Apud Syncellum*, p. 37.

† *Hiſt. Nat.* lib. vii. cap. 56.

2 not ſolely from idolatry;

It is generally thought that ſculpture had its origin from idolatry, as it was found neceſſary to place before the people the images of their gods to enliven the fervour of their devotion: but this is probably a miſtake. The worſhip of the heavenly bodies, as the only gods of the heathen nations, prevailed ſo long before the deification of dead men was thought of (ſee POLYTHEISM), that we cannot ſuppoſe mankind to have been, during all that time, ignorant of the art of hieroglyphical writing. But the deification of departed heroes undoubtedly gave riſe to the almoſt univerſal practice of repreſenting the gods by images of a human form; and therefore we muſt conclude, that the elements of ſculpture were known before that art was employed to enliven the devotion of idolatrous worſhippers. The pyramids and obeliſks of Egypt, which were probably temples, or rather altars, dedicated to the ſun (ſee PYRAMID), were covered from top to bottom with hieroglyphical emblems of men, beaſts, birds, fiſhes, and reptiles, at a period prior to that in which there is any unexceptionable evidence that mere ſtatue-worſhip prevailed even in that nurſery of idolatry.

3 though it probably contributed to carry the art to perfection,

But though it appears thus evident that picture-writing was the firſt employment of the ſculptor, we are far from imagining that idolatrous worſhip did not contribute to carry his art to that perfection which it attained in ſome of the nations of antiquity. Even in the dark ages of Europe, when the other fine arts were almoſt extinguiſhed, the mummery of the church of Rome, and the veneration which ſhe taught for her ſaints and martyrs, preſerved among the Italians ſome veſtiges of the ſiſter-arts of ſculpture and painting; and therefore, as human nature is everywhere the ſame, it is reaſonable to believe that a ſimilar veneration for heroes and demigods would, among the ancient nations, have a ſimilar effect. But if this be ſo, the preſumption is, that the Chaldeans were the firſt who invented the art of hewing blocks of wood and ſtone into the figures of men and other animals; for the Chaldeans were unqueſtionably the firſt idolaters, and their early progreſs in ſculpture is confirmed by the united teſtimonies of Beroſus, Alexander Polyhiſtor, Apollodorus, and Pliny; not to mention the eaſtern tradition, that the father of Abraham was a ſtatuary.

4 Mr Bromley's theory, that ſculpture was invented by the Scythians,

Againſt this concluſion Mr Bromley, in his late Hiſtory of the Fine Arts, has urged ſome plauſible arguments. In ſtating theſe he profeſſes not to be original, or to derive his information from the fountain-head of antiquity. He adopts, as he tells us, the theory of a French writer, who maintains, that in the year of the world 1949, about 300 years after the deluge, the Scythians under Brouma, a deſcendant of Magog the ſon of Japhet, extended their conqueſts over the greater part of Aſia. According to this ſyſtem, Brouma was not only the civilizer of India, and the author of the braminical doctrines, but alſo diffuſed the principles of the Scythian mythology over Egypt, Phœnicia, Greece, and the continent of Aſia.

Of theſe principles Mr Bromley has given us no diſtinct enumeration; the account which he gives of them is not to be found in one place, but to be collected from a variety of diſtant paſſages. In attempting therefore to preſent the ſubſtance of his ſcattered hints in one view, we will not be confident that we have omitted none of them. The ox, ſays he, was the Scythian emblem of the generator of animal life, and hence it became the principal divinity of the Arabians. The ſerpent was the ſymbol of the ſource of intelligent nature. Theſe were the common points of union in all the firſt religions

religions of the earth. From Egypt the Iſraelites carried with them a religious veneration for the ox and the ſerpent. Their veneration for the ox appeared ſoon after they marched into the wilderneſs, when in the abſence of Moſes they called upon Aaron to make them gods which ſhould go before them. The idea of having an idol to go before them, ſays our author, was completely Scythian; for ſo the Scythians acted in all their progreſs through Aſia, with this difference, that their idol was a living animal. The Iſraelites having gained their favourite god, which was an ox (not a calf as it is rendered in the book of Exodus), next proceeded to hold a feſtival, which was to be accompanied with dancing; a ſpecies of gaiety common in the feſtivals which were held in adoration of the emblematic *Urotal* or ox in that very part of Arabia near Mount Sinai where this event took place. It is mentioned too as a curious and important fact, that the ox which was revered in Arabia was called *Adonai*. Accordingly Aaron announcing the feaſt to the ox or golden calf, ſpeaks thus, *to-morrow is a feaſt to Adonai*, which is in our tranſlation rendered *to the Lord*. In the time of Jeroboam we read of the golden calves ſet up as objects of worſhip at Bethel and Dan. Nor was the reverence paid to the ox confined to Scythia, to Egypt, and to Aſia; it extended much farther. The ancient Cimbri, as the Scythians did, carried an ox of bronze before them on all their expeditions. Mr Bromley alſo informs us, that as great reſpect was paid to the living ox among the Greeks as was offered to its ſymbol among other nations.

The emblem of the ſerpent, continues Mr Bromley, was marked yet more decidedly by the expreſs direction of the Almighty. That animal had ever been conſidered as emblematic of the ſupreme generating power of intelligent life: And was that idea, ſays he, diſcouraged, ſo far as it went to be a ſign or ſymbol of life, when God ſaid to Moſes, "Make thee a brazen ſerpent, and ſet it on a pole, and it ſhall come to paſs that every one who is bitten, when he looketh on it, ſhall live." In Egypt the ſerpent ſurrounded their Iſis and Oſiris, the diadems of their princes, and the bonnets of their prieſts. The ſerpent made a diſtinguiſhed figure in Grecian ſculpture. The fable of Echidne, the mother of the Scythians, gave her figure terminating as a ſerpent to all the founders of ſtates in Greece; from which their earlieſt ſculptors repreſented in that form the Titan princes, Cecrops, Draco, and even Ericthonius. Beſides the ſpear of the image of Minerva, which Phidias made for the citadel of Athens, he placed a ſerpent, which was ſuppoſed to guard that goddeſs.

The ſerpent was combined with many other figures. It ſometimes was coiled round an egg as an emblem of the creation; ſometimes round a trident, to ſhow its power over the ſea; ſometimes it encircled a flambeau, to repreſent life and death.

In Egypt, as well as in Scythia and India, the divinity was repreſented on the leaves of the tamara or lotus. Pan was worſhipped as a god in that country, as well as over the eaſt. Their ſphinxes, and all their combined figures of animal creation, took their origin from the mother of the Scythians, who brought forth an offspring that was half a woman and half a ſerpent. Their pyramids and obeliſks aroſe from the idea of flame; the firſt emblem of the ſupreme principle, introduced by the Scythians, and which even the influence of Zoroaſter and the Magi could not remove.

We are told that the Bacchus of the Greeks is derived from the Brouma of the Indians; that both are repreſented as ſeated on a ſwan ſwimming over the waves, to indicate that each was the god of humid nature, not the god of wine, but the god of waters. The mitre of Bacchus was ſhaped like half an egg; an emblem taken from this circumſtance, that at the creation the egg from which all things ſprung was divided in the middle. Pan alſo was revered among the Scythians; and from that people were derived all the emblems by which the Greeks repreſented this divinity.

It would be tedious to follow our author through the whole of this ſubject; and were we to ſubmit to the labour of collecting and arranging his ſcattered materials, we ſhould ſtill view his ſyſtem with ſome degree of ſuſpicion. It is drawn, as he informs us, from the work of M. D'Ancarville, intitled, *Recherches ſur l'Origine, l'Eſprit, et les Progres, des Arts de la Grece.*

To form concluſions concerning the origin of nations, ill founded.
the riſe and progreſs of the arts and ſciences, without the aid of hiſtorical evidence, by analogies which are ſometimes accidental, and often fanciful, is a mode of reaſoning which cannot readily be admitted. There may indeed, we acknowledge, be reſemblances in the religion, language, manners, and cuſtoms, of different nations, ſo ſtriking and ſo numerous, that to doubt of their being deſcended from the ſame ſtock would ſavour of ſcepticiſm. But hiſtorical theories muſt not be adopted raſhly. We muſt be certain that the evidence is credible and ſatisfactory before we proceed to deduce any concluſions. We muſt firſt know whether the Scythian hiſtory itſelf be authentic, before we make any compariſon with the hiſtory of other nations. But what is called the Scythian hiſtory, every man of learning knows to be a collection of fables. Herodotus and Juſtin are the two ancient writers from whom we have the fulleſt account of that warlike nation; but theſe two hiſtorians contradict each other, and both write what cannot be believed of the ſame people at the ſame period of their progreſs. Juſtin tells us, that there was a long and violent conteſt between the Scythians and Egyptians about the antiquity of their reſpective nations; and after ſtating the arguments on each ſide of the queſtion, which, as he gives them *, are nothing to the purpoſe, he decides in favour of the claim of the Scythians. Herodotus was too partial to the Egyptians, not to give them the palm of antiquity: and he was probably in the right; for Juſtin deſcribes his moſt ancient of nations, even in the time of Darius Hyſtaſpes, as ignorant of all the arts of civil life. "They occupied their land in common (ſays he), and cultivated none of it. They had no houſes nor ſettled habitations, but wandered with their cattle from deſert to deſert. In theſe rambles they carried their wives and children in tumbrels covered with the ſkins of beaſts, which ſerved as houſes to protect them from the ſtorms of winter. They were without laws, governed by the dictates of natural equity. They coveted not gold or ſilver like the reſt of mankind, and lived upon milk and honey. Though they were expoſed to extreme cold, and had abundance of flocks, they knew not how to make garments of wool, but clothed themſelves in the ſkins of wild

* Lib. ii. cap. 1.

wild beafts †." This is the moft favourable account which any ancient writer gives of the Scythians. By Strabo ‡ and Herodotus § they are reprefented as the moft favage of mortals, delighting in war and bloodfhed, cutting the throats of all ftrangers who came among them, eating their flefh, and making cups and pots of their fkulls. Is it conceivable that fuch favages could be fculptors; or that, even fuppofing their manners to have been fuch as Juftin reprefents them, a people fo fimple and ignorant could have impofed their mythology upon the Chaldeans, Phenicians, and Egyptians, whom we know by the moft incontrovertible evidence to have been great and polifhed nations fo early as in the days of Abraham? No! We could as foon admit other novelties of more importance, with which the French of the prefent age pretend to enlighten the world, as this origin affigned by Mr Bromley to the art of fculpture, unlefs fupported by better authority than that of D'Ancarville.

† Lib. ii. cap. 2.
‡ Lib. vii.
§ Lib. iv. cap. 62.

The inference of our author from the name of the facred ox in Arabia, and from the dancing and gaiety which were common in the religious feftivals of the Arabians, appears to us to be very haftily drawn. At the early period of the departure of the Ifraelites from Egypt, the language of the Hebrews, Egyptians, and Arabians, differed not more from each other than do the different dialects of the Greek tongue which are found in the poems of Homer (fee PHILOLOGY, Sect. III.); and it is certain, that for many years after the formation of the golden-calf, the Hebrews were ftrangers to every fpecies of idolatry but that which they had brought with them from their houfe of bondage. See REMPHAN.

Taking for granted, therefore, that the Scythians did not impofe their mythology on the eaftern nations, and that the art of fculpture, as well as hieroglyphic writing and idolatrous worfhip, prevailed firft among the Chaldeans, we fhall endeavour to trace the progrefs of this art through fome other nations of antiquity, till we bring it to Greece, where it was carried to the higheft perfection to which it has yet attained.

The firft intimation that we have of the art of fculpture is in the book of Genefis, where we are informed, that when Jacob, by the divine command, was returning to Canaan, his wife Rachel carried along with her the teraphim or idols of her father. Thefe we are affured were fmall, fince Rachel found it fo eafy to conceal them from her father, notwithftanding his anxious fearch. We are ignorant, however, how thefe images were made, or of what materials they were compofed. The firft perfon mentioned as an artift of eminence is Bezaleel, who formed the cherubims which covered the mercy-feat.

6
Egyptian fculpture.

The Egyptians alfo cultivated the art of fculpture; but there were two circumftances which obftructed its progrefs, 1. The perfons of the Egyptians were not poffeffed of the graces of form, of elegance, or of fymmetry; and of confequence they had no perfect ftandard to model their tafte. They refembled the Chinefe in the caft of their face, in their great bellies, and in the clumfy rounding of their contours. 2. They were reftrained by their laws to the principles and practices of their anceftors, and were not permitted to introduce any innovations. Their ftatues were always formed in the fame ftiff attitude, with the arms hanging perpendicularly down the fides. What perfection were they capable of who knew no other attitude than that of chairmen? So far were they from attempting any improvements, that in the time of Adrian the art continued in the fame rude ftate as at firft; and when their flavifh adulation for that emperor induced them to place the ftatue of his favourite Antinous among the objects of their worfhip, the fame inanimate ftiffnefs in the attitude of the body and pofition of the arms was obferved. We believe it will fcarcely be neceffary to inform our readers that the Egyptian ftatue juft now mentioned is very different from the celebrated ftatue of Antinous, of which fo many moulds have been taken that imitations of it are now to be met with almoft in every cabinet in Europe.

Nothwithftanding the attachment of the Egyptians to ancient ufages, Winkelman thinks he has difcovered two different ftyles of fculpture which prevailed at different periods. The firft of thefe ends with the conqueft of Egypt by Cambyfes. The fecond begins at that time, and extends beyond the reign of Alexander the Great. In the firft ftyle, the lines which form the contour are ftraight and projecting a little; the pofition is ftiff and unnatural: In fitting figures the legs are parallel, the feet fqueezed together, and the arms fixed to the fides; but in the figures of women the left arm is folded acrofs the breaft; the bones and mufcles are faintly difcernible; the eyes are flat and looking obliquely, and the eyebrows funk—features which deftroy entirely the beauty of the head; the cheek-bones are high, the chin fmall and piked; the ears are generally placed higher than in nature, and the feet are too large and flat. In fhort, if we are to look for any model in the ftatues of Egypt, it is not for the model of beauty but of deformity. The ftatues of men are naked, only they have a fhort apron, and a few folds of drapery furrounding their waift: The veftments of women are only diftinguifhable by the border, which rifes a little above the furface of the ftatue. In this age it is evident the Egyptians knew little of drapery.

7
First ftyle.

Of the fecond ftyle of fculpture practiced among the Egyptians, Winkelman thinks he has found fpecimens in the two figures of bafaltes in the Capitol, and in another figure at Villa Albani, the head of which has been renewed. The firft two of thefe, he remarks, bear vifible traces of the former ftyle, which appear efpecially in the form of the mouth and fhortnefs of the chin. The hands poffefs more elegance; and the feet are placed at a greater diftance from each other, than was cuftomary in more ancient times. In the firft and third figures the arms hang down clofe to the fides. In the fecond they hang more freely. Winkelman fufpects that thefe three ftatues have been made after the conqueft of Egypt by the Greeks. They are clothed with a tunic, a robe, and a mantle. The tunic, which is puckered into many folds, defcends from the neck to the ground. The robe in the firft and third ftatues feems clofe to the body, and is only perceptible by fome little folds. It is tied under the breaft, and covered by the mantle, the two buttons of which are placed under the epaulet.

8
Second ftyle.

The Antinous of the Capitol is compofed of two pieces, which are joined under the haunches. But as all the Egyptian ftatues which now remain have been hewn out of one block, we muft believe that Diodorus, in in ſaying the ſtone was divided, and each half finiſhed by a ſeparate artizan, ſpoke only of a coloſſus. The ſame author informs us, that the Egyptians divided the human body into $24\frac{1}{4}$ parts; but it is to be regretted that he has not given a more minute detail of that diviſion.

The Egyptian ſtatues were not only formed by the chiſel, they were alſo poliſhed with great care. Even thoſe on the ſummit of an obeliſk, which could only be viewed at a diſtance, were finiſhed with as much labour and care as if they had admitted a cloſe inſpection. As they are generally executed in granite or baſaltes, ſtones of a very hard texture, it is impoſſible not to admire the indefatigable patience of the artiſts.

The eye was often of different materials from the reſt of the ſtatue; ſometimes it was compoſed of a precious ſtone or metal. We are aſſured that the valuable diamond of the empreſs of Ruſſia, the largeſt and moſt beautiful hitherto known, formed one of the eyes of the famous ſtatue of Scheringham in the temple of Brama.

Thoſe Egyptian ſtatues which ſtill remain are compoſed of wood or baked earth: and the ſtatues of earth are covered with green enamel.

9 Phenician ſculpture. The Phenicians poſſeſſed both a character and ſituation highly favourable to the cultivation of ſtatuary. They had beautiful models in their own perſons, and their induſtrious character qualified them to attain perfection in every art for which they had a taſte. Their ſituation raiſed a ſpirit of commerce, and commerce induced them to cultivate the arts. Their temples ſhone with ſtatues and columns of gold, and a profuſion of emeralds was everywhere ſcattered. All the great works of the Phenicians have been unfortunately deſtroyed; but many of the Carthaginian medals are ſtill preſerved, ten of which are depoſited in the cabinet of the grand duke of Florence. But though the Carthaginians were a colony of Phenicians, we cannot from their works judge of the merit of their anceſtors.

10 This art not cultivated among the Perſians. The Perſians made no diſtinguiſhed figure in the arts of deſign. They were indeed ſenſible to the charms of beauty, but they did not ſtudy to imitate them. Their dreſs, which conſiſted of long flowing robes concealing the whole perſon, prevented them from attending to the beauties of form. Their religion, too, which taught them to worſhip the divinity in the emblem of fire, and that it was impious to repreſent him under a human form, ſeemed almoſt to prohibit the exerciſe of this art, by taking away thoſe motives which alone could give it dignity and value; and as it was not cuſtomary among them to raiſe ſtatues to great men, it was impoſſible that ſtatuary could flouriſh in Perſia.

11 Etrurian ſculpture. The Etrurians or ancient Tuſcans, in the opinion of Winkelman, carried this art to ſome degree of perfection at an earlier period than the Greeks. It is ſaid to have been introduced before the ſiege of Troy by Dedalus, who, in order to eſcape the reſentment of Minos king of Crete, took refuge in Sicily, from whence he paſſed into Italy, where he left many monuments of his art. Pauſanias and Diodorus Siculus informs us, that ſome works aſcribed to him were to be ſeen when they wrote, and that theſe poſſeſſed that character of majeſty which afterwards diſtinguiſhed the labours of Etruria.

A character ſtrongly marked forms the chief diſtinction in thoſe productions of Etruria which have deſcended to us. Their ſtyle was indeed harſh and overcharged; a fault alſo committed by Michael Angelo the celebrated painter of modern Etruria; for it is not to be ſuppoſed that a people of ſuch rude manners as the Etrurians could communicate to their works that vividneſs and beauty which the elegance of Grecian manners inſpired. On the other hand, there are many of the Tuſcan ſtatues which bear ſo cloſe a reſemblance to thoſe of Greece, that antiquarians have thought it probable that they were conveyed from that country, or Magna Græcia, into Etruria, about the time of the Roman conqueſt, when Italy was adorned with the ſpoils of Greece.

12 First ſtyle. Among the monuments of Etrurian art two different ſtyles have been obſerved. In the firſt the lines are ſtraight, the attitude ſtiff, and no idea of beauty appears in the formation of the head. The contour is not well rounded, and the figure is too ſlender. The head is oval, the chin piked, the eyes flat, and looking aſquint.

Theſe are the defects of an art in a ſtate of infancy, which an accompliſhed maſter could never fall into, and are equally conſpicuous in Gothic ſtatues as in the productions of the ancient natives of Florence. They reſemble the ſtyle of the Egyptians ſo much, that one is almoſt induced to ſuppoſe that there had once been a communication between theſe two nations; but others think that this ſtyle was introduced by Dedalus.

13 Second ſtyle. Winkelman ſuppoſes that the ſecond epoch of this art commenced in Etruria, about the time at which it had reached its greateſt perfection in Greece, in the age of Phidias; but this conjecture is not ſupported by any proofs. To deſcribe the ſecond ſtyle of ſculpture among the Etrurians, is almoſt the ſame as to deſcribe the ſtyle of Michael Angelo and his numerous imitators. The joints are ſtrongly marked, the muſcles raiſed, the bones diſtinguiſhable; but the whole mien harſh. In deſigning the bone of the leg, and the ſeparation of the muſcles of the calf, there is an elevation and ſtrength above life. The ſtatues of the gods are deſigned with more delicacy. In forming them, the artiſts were anxious to ſhow that they could exerciſe their power without that violent diſtenſion of the muſcles which is neceſſary in the exertions of beings merely human; but in general their attitudes are unnatural, and the actions ſtrained. If a ſtatue, for inſtance, hold any thing with its fore fingers, the reſt are ſtretched out in a ſtiff poſition.

According to ancient hiſtory, the Greeks did not emerge from the ſavage ſtate till a long time after the Egyptians, Chaldeans, and Indians, had arrived at a conſiderable degree of civilization. The original rude inhabitants of Greece were civilized by colonies which arrived among them, at different times, from Egypt and Phenicia. Theſe brought along with them the religion, the letters, and the arts of their parent countries: and if ſculpture had its origin from the worſhip of idols, there is reaſon to believe that it was one of the arts which were thus imported; for that the gods of Greece were of Egyptian and Phenician extraction is a fact incontrovertible; (ſee MYSTERIES, MYTHOLOGY, PHILOLOGY, Sect. VII. PHILOSOPHY, N° 19, and TITAN). The original ſtatues of the gods, however, were very rude. The earlieſt objects of idolatrous worſhip

worship have everywhere been the heavenly bodies; and the symbols consecrated to them were generally pillars of a conical or pyramidal figure. It was not till hero-worship was engrafted on the planetary, that the sculptor thought of giving to the sacred statue any part of the human form (see POLYTHEISM, N° 19, 23.); and it appears to have been about the era of their revolution in idolatry that the art of sculpture was introduced among the Greeks. The first representations of their gods were round stones placed upon cubes or pillars; and these stones they afterwards formed roughly, so as to give them something of the appearance of a head. Agreeable to this description was a Jupiter, which Pausanias saw in Tegeum, in Arcadia. These representations were called *Hermes;* not that they represented Mercury, but from the word *Herma*, which signified a rough stone. It is the name which Homer gives to the stones which were used to fix vessels to the shore. Pausanias saw at Pheres 30 deities made of unformed blocks or cubical stones. The Lacedemonians represented Castor and Pollux by two parallel posts; and a transverse beam was added, to express their mutual affection.

If the Greeks derived from foreign nations the rudiments of the arts, it must redound much to their honour, that in a few centuries they carried them to such wonderful perfection as entirely to eclipse the fame of their masters. It is by tracing the progress of sculpture among them that we are to study the history of this art; and we shall see its origin and successive improvements correspond with nature, which always operates slowly and gradually.

View of Grecian Sculpture.

14 Causes which promoted the art of sculpture in Greece.

The great superiority of the Greeks in the art of sculpture may be ascribed to a variety of causes. The influence of climate over the human body is so striking, that it must have fixed the attention of every thinking man who has reflected on the subject. The violent heats of the torrid zone, and the excessive cold of the polar regions, are unfavourable to beauty. It is only in the mild climates of the temperate regions that it appears in its most attractive charms. Perhaps no country in the world enjoys a more serene air, less tainted with mists and vapours, or possesses in a higher degree that mild and genial warmth which can unfold and expand the human body into all the symmetry of muscular strength, and all the delicacies of female beauty in greater perfection, than the happy climate of Greece; and never was there any people that had a greater taste for beauty, or were more anxious to improve it. Of the four wishes of Simonides, the second was to have a handsome figure. The love of beauty was so great among the Lacedemonian women, that they kept in their chambers the statues of Nereus, of Narcissus, of Hyacinthus, and of Castor and Pollux; hoping that by often contemplating them they might have beautiful children.

There was a variety of circumstances in the noble and virtuous freedom of the Grecian manners that rendered these models of beauty peculiarly subservient to the cultivation of the fine arts. There were no tyrannical laws, as among the Egyptians, to check their progress. They had the best opportunities to study them in the public places, where the youth, who needed no other veil than chastity and purity of manners, performed their various exercises quite naked. They had the strongest motives to cultivate sculpture, for a statue was the highest honour which public merit could attain. It was an honour ambitiously sought, and granted only to those who had distinguished themselves in the eyes of their fellow citizens. As the Greeks preferred natural qualities to acquired accomplishments, they decreed the first rewards to those who excelled in agility and strength of body. Statues were often raised to wrestlers. Even the most eminent men of Greece, in their youth, sought renown in gymnastic exercises. Chrysippus and Cleanthes distinguished themselves in the public games before they were known as philosophers. Plato appeared as a wrestler both at the Isthmian and Pythian games; and Pythagoras carried off the prize at Elis, (see PYTHAGORAS). The passion by which they were inspired was the ambition of having their statues erected in the most sacred place of Greece, to be seen and admired by the whole people. The number of statues erected on different occasions was immense; of course the number of artists must have been great, their emulation ardent, and their progress rapid.

As most of their statues were decreed for those who vanquished in the public games, the artists had the opportunity of seeing excellent models; for those who surpassed in running, boxing, and wrestling, must in general have been well formed, yet would exhibit different kinds of beauty.

The high estimation in which sculptors were held was very favourable to their art. Socrates declared the artists the only wise men. An artist could be a legislator, a commander of armies, and might hope to have his statue placed beside those of Miltiades and Themistocles, or those of the gods themselves. Besides, the honour and success of an artist did not depend on the caprice of pride or of ignorance. The productions of art were estimated and rewarded by the greatest sages in the general assembly of Greece, and the sculptor who had executed his work with ability and taste was confident of obtaining immortality.

It was the opinion of Winkelman, that liberty was highly favourable to this art; but, though liberty is absolutely necessary to the advancement of science, it may be doubted whether the fine arts owe their improvement to it. Sculpture flourished most in Greece, when Pericles exercised the power of a king; and in the reign of Alexander, when Greece was conquered. It attained no perfection in Rome till Augustus had enslaved the Romans. It revived in Italy under the patronage of the family of Medici, and in France under the despotic rule of Louis XIV. It is the love of beauty, luxury, wealth, or the patronage of a powerful individual, that promotes the progress of this art.

15 Grecian ideas of beauty.

It will now be proper to give a particular account of the ideas which the Greeks entertained concerning the standard of beauty in the different parts of the human body. And with respect to the head, the profile which they chiefly admired is peculiar to dignified beauty.

16 The profile.

It consists in a line almost straight, or marked by such slight and gentle inflections as are scarcely distinguishable from a straight line. In the figures of women and young persons, the forehead and nose form a line approaching to a perpendicular.

Ancient

17 The forehead. Ancient writers, as well as artists, assure us that the Greeks reckoned a small forehead a mark of beauty, and a high forehead a deformity. From the same idea, the Circassians wore their hair hanging down over their foreheads almost to their eyebrows. To give an oval form to the countenance, it is necessary that the hair should cover the forehead, and thus make a curve about the temples; otherwise the face, which terminates in an oval form in the inferior part, will be angular in the higher part, and the proportion will be destroyed. This rounding of the forehead may be seen in all handsome persons, in all the heads of ideal beauty in ancient statues, and especially in those of youth. It has been overlooked, however, by modern statuaries. Bernini, who modelled a statue of Louis XIV. in his youth, turned back the hair from the forehead.

18 The eyes. It is generally agreed that large eyes are beautiful; but their size is of less importance in sculpture than their form, and the manner in which they are enchased. In ideal beauty, the eyes are always sunk deeper than they are in nature, and consequently the eyebrows have a greater projection. But in large statues, placed at a certain distance, the eyes, which are of the same colour with the rest of the head, would have little effect if they were not sunk. By deepening the cavity of the eye, the statuary increases the light and shade, and thus gives the head more life and expression. The same practice is used in small statues. The eye is a characteristic feature in the heads of the different deities. In the statues of Apollo, Jupiter, and Juno, the eye is large and round. In those of Pallas they are also large; but by lowering the eyelids, the virgin air and expression of modesty are delicately marked. Venus has small eyes, and the lower eyelid being raised a little, gives them a languishing look and enchanting sweetness. It is only necessary to see the Venus de Medicis to be convinced that large eyes are not essential to beauty, especially if we compare her small eyes with those which resemble them in nature. The beauty of the eyebrows consists in the fineness of the hair, and in the sharpness of the bone which covers them; and masters of the art considered the joining of the eyebrows as a deformity, though it is sometimes to be met with in ancient statues.

19 The mouth. The beauty of the mouth is peculiarly necessary to constitute a fine face. The lower lip must be fuller than the upper, in order to give an elegant rounding to the chin. The teeth seldom appear, except in laughing satyrs. In human figures the lips are generally close, and a little opened in the figures of the gods, The lips of Venus are half open.

In figures of ideal beauty, the Grecian artists never interrupted the rounding of the chin by introducing a dimple: for this they considered not as a mark of beauty, and only to be admitted to distinguish individuals. The dimple indeed appears in some ancient statues, but antiquaries suspect it to be the work of a modern hand. It is suspected also, that the dimple which is sometimes found on the cheeks of ancient statues is a modern innovation.

20 The ears. No part of the head was executed by the ancients with more care than the ears, though little attention has been given to them by modern artists. This character is so decisive, that if we observe in any statue that the ears are not highly finished, but only roughly marked, we may conclude with certainty that we are examining a modern production. The ancients were very attentive to copy the precise form of the ear in taking likenesses. Thus, where we meet with a head the ears of which have a very large interior opening, we know it to be the head of Marcus Aurelius.

21 The hair. The manner in which the ancient artists formed the hair also enables us to distinguish their works from those of the moderns. On hard and coarse stones the hair was short, and appeared as if it had been combed with a wide comb; for that kind of stone was difficult to work, and could not without immense labour be formed into curled and flowing hair. But the figures executed in marble in the most flourishing period of the art have the hair curled and flowing; at least where the head was not intended to be an exact resemblance, for then the artist conformed to his model. In the heads of women, the hair was thrown back, and tied behind in a waving manner, leaving considerable intervals; which gives the agreeable variety of light and shade, and produces the effects of the claro-obscuro. The hair of the Amazons is disposed in this manner. Apollo and Bacchus have their hair falling down their shoulders; and young persons, till they arrived at manhood, wore their hair long. The colour of the hair which was reckoned most beautiful, was fair; and this they gave without distinction to the most beautiful of their gods, Apollo and Bacchus, and likewise to their most illustrious heroes.

22 The hand. Although the ravages of time have preserved but few of the hands or feet of ancient statues, it is evident from what remains how anxious the Grecian artists were to give every perfection to these parts. The hands of young persons were moderately plump, with little cavities or dimples at the joints of the fingers. The fingers tapered very gently from the root to the point, like well-proportioned columns, and the joints were scarcely perceptible. The terminating joint was not bent, as it commonly appears in modern statues.

23 The legs and feet. In the figures of young men the joints of the knee are faintly marked. The knee unites the leg to the thigh without making any remarkable projections or cavities. The most beautiful legs and best-turned knees, according to Winkelman, are preserved in the Apollo Sauroctones, in the Villa Burghese; in the Apollo which has a swan at its feet; and in the Bacchus of Villa Medicis. The same able connoisseur remarks, it is rare to meet with beautiful knees in young persons, or in the elegant representations of art. As the ancients did not cover the feet as we do, they gave to them the most beautiful turning, and studied the form of them with the most scrupulous attention.

The breasts of men were large and elevated. The breasts of women did not possess much amplitude. The figures of the deities have always the breasts of a virgin, the beauty of which the ancients made to consist in a gentle elevation. So anxious were the women to resemble this standard, that they used several arts to restrain the growth of their breasts. The breasts of the nymphs and goddesses were never represented swelling, because that is peculiar to those women who suckle. The paps of Venus contract and end in a point, this being considered as an essential characteristic of perfect beauty. Some of the moderns have transgressed these rules, and have fallen into great improprieties.

The

The lower part of the body in the ftatues of men was formed like that of the living body after a profound fleep and good digeftion. The navel was confiderably funk, efpecially in female ftatues.

25
Ideal beauty.

As beauty never appears in equal perfection in every part of the fame individual, perfect or ideal beauty can only be produced by felecting the moft beautiful parts from different models; but this muft be done with fuch judgement and care, that thefe detached beauties when united may form the moft exact fymmetry. Yet the ancients fometimes confined themfelves to one individual, even in the moft flourifhing age. Theodorus, whom Socrates and his difciples vifited, ferved as a model to the artifts of his time. Phryne alfo appears to have been a model to the painters and fculptors. But Socrates, in his converfation with Parrhafius, fays, that when a perfect beauty was to be produced, the artifts joined together the moft ftriking beauties which could be collected from the fineft figures. We know that Zeuxis, when he was going to paint Helen, united in one picture all the beauties of the moft handfome women of Crotona.

26
The drapery of ftatues.

THE Grecian fculptors, who reprefented with fuch fuccefs the moft perfect beauty of the human form, were not regardlefs of the drapery of their ftatues. They clothed their figures in the moft proper ftuff, which they wrought into that fhape which was beft calculated to give effect to their defign.

The veftments of women in Greece generally confifted of linen cloth, or fome other light ftuff, and in latter times of filk and fometimes of woollen cloth. They had alfo garments embroidered with gold. In the works of fculpture, as well as in thofe of painting, one may diftinguifh the linen by its tranfparency and fmall united folds. The other light ftuffs which were worn by the women (A) were generally of cotton produced in the ifle of Cos; and thefe the art of ftatuary was able to diftinguifh from the linen veftments. The cotton cloth was fometimes ftriped, and fometimes embellifhed with a profufion of flowers. Silk was alfo employed; but whether it was known in Greece before the time of the Roman emperors cannot eafily be determined. In paintings, it is diftinguifhable by changing its colour in different lights to red, violet, and fky-blue. There were two forts of purple; that which the Greeks called the *colour of the fea*, and Tyrian purple, which refembled lac. Woollen garments are eafily known by the amplitude of their folds. Befides thefe, cloth of gold fometimes compofed their drapery: but it was not like the modern fabric, confifting of a thread of gold or of filver fpun with a thread of filk; it was compofed of gold or filver alone, without any mixture.

The veftments of the Greeks, which deferve particular attention, are the tunic, the robe, and the mantle.

27
The tunic.

The tunic was that part of the drefs which was next to the body. It may be feen in fleeping figures, or in thofe in difhabille; as in the Flora Farnefe, and in the ftatues of the Amazons in the Capitol. The youngeft of the daughters of Niobe, who throws herfelf at her mother's fide, is clothed only with a tunic. It was of linen, or fome other light ftuff, without fleeves, fixed to the fhoulders by a button, fo as to cover the whole breaft. None but the tunics of the goddefs Ceres and comedians have long ftraight fleeves.

28
The robe.

The robes of women commonly confifted of two long pieces of woollen cloth, without any particular form, attached to the fhoulders by a great many buttons, and fometimes by a clafp. They had ftraight fleeves which came down to the wrifts. The young girls, as well as the women, faftened their robe to their fide by a cincture, in the fame way as the high-prieft of the Jews faftened his, as it is ftill done in many parts of Greece. The cincture formed on the fide a knot of ribbons fometimes refembling a rofe in fhape, which has been particularly remarked in the two beautiful daughters of Niobe. In the younger of thefe the cincture is feen paffing over the fhoulders and the back. Venus has two cinctures, the one paffing over the fhoulder, and the other furrounding the waift. The latter is called *ceftus* by the poets.

29
The mantle.

The mantle was called *peplon* by the Greeks, which fignifies properly the mantle of Pallas. The name was afterwards applied to the mantles of the other gods, as well as to thofe of men. This part of the drefs was not fquare, as fome have imagined, but of a roundifh form. The ancients indeed fpeak in general of fquare mantles, but they received this fhape from four taffels which were affixed to them; two of thefe were vifible, and two were concealed under the mantle. The mantle was brought under the right arm, and over the left fhoulder; fometimes it was attached to the fhoulder by two buttons, as may be feen in the beautiful ftatue of Leucothoe at Villa Albani.

30
The colour of the veftments.

The colour of veftments peculiar to certain ftatues is too curious to be omitted. To begin with the figures of the gods.—The drapery of Jupiter was red, that of Neptune is fuppofed by Winkelman to have been fea-green. The fame colour alfo belonged to the Nereids and Nymphs. The mantle of Apollo was blue or violet. Bacchus was dreffed in white. Martianus Capella affigns green to Cybele. Juno's veftments were fky-blue, but fhe fometimes had a white veil. Pallas was robed in a flame-coloured mantle. In a painting of Herculaneum, Venus is in flowing drapery of a golden yellow. Kings were arrayed in purple; priefts in white; and conquerors fometimes in fea-green.

With refpect to the head, women generally wore no covering but their hair; when they wifhed to cover their head, they ufed the corner of their mantle.—Sometimes we meet with veils of a fine tranfparent texture. Old women wore a kind of bonnet upon their head, an example of which may be feen in a ftatue in the Capitol, called the *Præfica;* but Winkelman thinks it is a ftatue of Hecuba.

The covering of the feet confifted of fhoes or fandals. The fandals were generally an inch thick, and compofed of more than one fole of cork. Thofe of Pallas in Villa Albani has two foles, and other ftatues had no lefs than five.

WINKELMAN

(A) Men fometimes wore cotton, but all who did fo were reckoned effeminate.

31 Four ſtyles of this art among the Greeks.

WINKELMAN has aſſigned four different ſtyles to this art. The *ancient* ſtyle, which continued until the time of Phidias; the *grand* ſtyle, formed by that celebrated ſtatuary; the *beautiful*, introduced by Praxiteles, Apelles, and Lyſippus; and the *imitative* ſtyle, practiſed by thoſe artiſts who copied the works of the ancient maſters.

32 The ancient ſtyle.

The moſt authentic monuments of the ancient ſtyle are medals, containing an inſcription, which leads us back to very diſtant times. The writing is from right to left in the Hebrew manner; a uſage which was abandoned before the time of Herodotus. The ſtatue of Agamemnon at Elis, which was made by Onatas, has an inſcription from right to left. This artiſan flouriſhed 50 years before Phidias; it is in the intervening period therefore between theſe two artiſts, that we are to look for the ceſſation of this practice. The ſtatues formed in the ancient ſtyle were neither diſtinguiſhed by beauty of ſhape nor by proportion, but bore a cloſe reſemblance to thoſe of the Egyptians and Etrurians (B); the eyes were long and flat; the ſection of the mouth not horizontal; the chin was pointed; the curls of the hair were ranged in little rings, and reſembled grains incloſed in a heap of raiſins. What was ſtill worſe, it was impoſſible by inſpecting the head to diſtinguiſh the ſex.

The characters of this ancient ſtyle were theſe: The deſigning was energetic, but harſh; it was animated, but without gracefulneſs; and the violence of the expreſſion deprived the whole figure of beauty.

33 The grand ſtyle.

The grand ſtyle was brought to perfection by Phidias, Polycletus, Scopas, Alcamenes, Myron, and other illuſtrious artiſts. It is probable, from ſome paſſages of ancient writers, that in this ſtyle were preſerved ſome characters of the ancient manner, ſuch as the ſtraight lines, the ſquares and angles. The ancient maſters, ſuch as Polycletus, being the legiſlators of proportions, ſays Winkelman, and of conſequence thinking they had a right to diſtribute the meaſures and dimenſions of the parts of the human body, have undoubtedly ſacrificed ſome degree of the form of beauty to a grandeur which is harſh, in compariſon of the flowing contours and graceful forms of their ſucceſſors.—The moſt conſiderable monuments of the grand ſtyle are the ſtatues of Niobe and her daughters, and a figure of Pallas, to be ſeen in Villa Albani; which, however, muſt not be confounded with the ſtatue which is modelled according to the firſt ſtyle, and is alſo found in the ſame place. The head poſſeſſes all the characters of dignified beauty, at the ſame time exhibiting the rigidneſs of the ancient ſtyle. The face is defective in gracefulneſs; yet it is evident how eaſy it would have been to give the features more roundneſs and grace. The figures of Niobe and her daughters have not, in the opinion of Winkelman, that auſterity of appearance which marks the age of the ſtatue of Pallas. They are characteriſed by grandeur and ſimplicity: ſo ſimple are the forms, that they do not appear to be the tedious productions of art, but to have been created by an inſtantaneous effort of nature.

34 The graceful ſtyle.

The third ſtyle was the graceful or beautiful. Lyſippus was perhaps the artiſt who introduced this ſtyle. Being more converſant than his predeceſſors with the ſweet, the pure, the flowing, and the beautiful lines of nature, he avoided the ſquare forms which the maſters of the ſecond ſtyle had too much employed. He was of opinion that the uſe of the art was rather to pleaſe than to aſtoniſh, and that the aim of the artiſt ſhould be to raiſe admiration by giving delight. The artiſts who cultivated this ſtyle did not, however, neglect to ſtudy the ſublime works of their predeceſſors. They knew that grace is conſiſtent with the moſt dignified beauty, and that it poſſeſſes charms which muſt ever pleaſe: they knew alſo that theſe charms are enhanced by dignity. Grace is infuſed into all the movements and attitudes of their ſtatues, and it appears in the delicate turns of the hair, and even in the adjuſting of the drapery. Every ſort of grace was well known to the ancients; and great as the ravages of time have been amongſt the works of art, ſpecimens are ſtill preſerved, in which can be diſtinguiſhed *dignified* beauty, *attractive* beauty, and a beauty *peculiar to infants*. A ſpecimen of dignified beauty may be ſeen in the ſtatue of one of the muſes in the palace of Barberini at Rome; and in the garden of the pope, on the Quirinal, is a ſtatue of another muſe, which affords a fine inſtance of attractive beauty. Winkelman ſays that the moſt excellent model of infant beauty which antiquity has tranſmitted to us is a ſatyr of a year old, which is preſerved, though a little mutilated, in Villa Albani.

35 The imitative ſtyle.

The great reputation of Praxiteles and Apelles raiſed an ardent emulation in their ſucceſſors, who deſpairing to ſurpaſs ſuch illuſtrious maſters, were ſatisfied with imitating their works. But it is well known that a mere imitator is always inferior to the maſter whom he attempts to copy. When no original genius appears, the art muſt therefore decline.

36 Materials of Grecian ſtatues.

CLAY was the firſt material which was employed in ſtatuary. An inſtance of this may be ſeen in a figure of Alcamenes in bas-relief in Villa Albani. The ancients uſed their fingers, and eſpecially their nails, to render certain parts more delicate and lively: hence aroſe the phraſe *ad unguem factus homo*, "an accompliſhed man." 37 Clay and plaſter. It was the opinion of Count Caylus that the ancients did not uſe models in forming their ſtatues. But to diſprove this, it is only neceſſary to mention an engraving on a ſtone in the cabinet of Stoſch, which repreſents Prometheus engraving the figure of a man, with a plummet in his hand to meaſure the proportions of his model. The ancients as well as the moderns made works in plaſter; but no ſpecimens remain except ſome figures in bas-relief, of which the moſt beautiful were found at Baia.

38 Ivory, ſilver, and gold.

The works made of ivory and ſilver were generally of a ſmall ſize. Sometimes, however, ſtatues of a prodigious ſize were formed of gold and ivory. The coloſſal Minerva of Phidias, which was compoſed of theſe materials, was 26 cubits high. It is indeed ſcarcely poſſible

(B) This is a proof additional to thoſe that will be found in the articles to which we have referred, that the Greeks received the rudiments of the art of ſculpture from the nations to which they were confeſſedly indebted for the elements of ſcience.

poſſible to believe that ſtatues of ſuch a ſize could entirely conſiſt of gold and ivory. The quantity of ivory neceſſary to a coloſſal ſtatue is beyond conception. M. de Paw calculates that the ſtatue of Jupiter Olympus, which was 54 feet high, would conſume the teeth of 300 elephants.

39 Marble.

The Greeks generally hewed their marble ſtatues out of one block, though they after worked the heads ſeparately, and ſometimes the arms. The heads of the famous group of Niobe and her daughters have been adapted to their bodies after being ſeparately finiſhed. It is proved by a large figure repreſenting a river, which is preſerved in Villa Albani, that the ancients firſt hewed their ſtatues roughly before they attempted to finiſh any part. When the ſtatue had received its perfect figure, they next proceeded to poliſh it with pumice-ſtone, and again carefully retouched every part with the chiſel.

40 Porphyry.

The ancients, when they employed porphyry, uſually made the head and extremities of marble. It is true, that at Venice there are four figures entirely compoſed of porphyry; but theſe are the productions of the Greeks of the middle age. They alſo made ſtatues of baſaltes and alabaſter.

41 Expreſſion and attitude.

WITHOUT expreſſion, geſture, and attitude, no figure can be beautiful, becauſe in theſe the graces always reſide. It was for this reaſon that the graces are always repreſented as the companions of Venus.

The expreſſion of tranquillity was frequent in Grecian ſtatues, becauſe, according to Plato, that was conſidered as the middle ſtate of the ſoul between pleaſure and pain. Experience, too, ſhows that in general the moſt beautiful perſons are endowed with the ſweeteſt and moſt engaging manner. Without a ſedate tranquillity dignified beauty could not exiſt. It is in this tranquillity, therefore, that we muſt look for the complete diſplay of genius.

42 In the ſtatues of the gods.

The moſt elevated ſpecies of tranquillity and repoſe was ſtudied in the figures of the gods. The father of the gods, and even inferior divinities, are repreſented without emotion or reſentment. It is thus that Homer paints Jupiter ſhaking Olympus by the motion of his hair and his eyebrows.

> Shakes his ambroſial curls, and gives the nod,
> The ſtamp of fate and ſanction of the god.

Jupiter is not always exhibited in this tranquil ſtate. In a bas-relief belonging to the marquis Rondini he appears ſeated on an arm-chair with a melancholy aſpect. The Apollo of the Vatican repreſents the god in a fit of rage againſt the ſerpent Python, which he kills at a blow. The artiſt, adopting the opinion of the poets, has made the noſe the ſeat of anger, and the lips the ſeat of diſdain.

43 In the ſtatues of heroes.

To expreſs the action of a hero, the Grecian ſculptors delineated the countenance of a noble virtuous character repreſſing his groans, and allowing no expreſſion of pain to appear. In deſcribing the actions of a hero the poet has much more liberty than the artiſt. The poet can paint them ſuch as they were before men were taught to ſubdue their paſſions by the reſtraints of law, or the refined cuſtoms of ſocial life. But the artiſt, obliged to ſelect the moſt beautiful forms, is reduced to the neceſſity of giving ſuch an expreſſion of the paſſions as may not ſhock our feelings and diſguſt us with his production. The truth of theſe remarks will be acknowledged by thoſe who have ſeen two of the moſt beautiful monuments of antiquity; one of which repreſents the fear of death, the other the moſt violent pains and ſufferings. The daughters of Niobe, againſt whom Diana has diſcharged her fatal arrows, are exhibited in that ſtate of ſtupefaction which we imagine muſt take place when the certain proſpect of death deprives the ſoul of all ſenſibility. The fable preſents us an image of that ſtupor which Eſchylus deſcribes as ſeizing the daughters of Niobe when they were transformed into a rock. The other monument referred to is the image of Laocoon, which exhibits the moſt agonizing pain that can affect the muſcles, the nerves, and the veins. The ſufferings of the body and the elevation of the ſoul are expreſſed in every member with equal energy, and form the moſt ſublime contraſt imaginable. Laocoon appears to ſuffer with ſuch fortitude, that, whilſt his lamentable ſituation pierces the heart, the whole figure fills us with an ambitious deſire of imitating his conſtancy and magnanimity in the pains and ſufferings that may fall to our lot.

Philoctetes is introduced by the poets ſhedding tears, uttering complaints, and rending the air with his groans and cries; but the artiſt exhibits him ſilent and bearing his pains with dignity. The Ajax of the celebrated painter Timomachus is not drawn in the act of deſtroying the ſheep which he took for the Grecian chiefs, but in the moments of reflection which ſucceeded that frenzy. So far did the Greeks carry their love of calmneſs and ſlow movements, that they thought a quick ſtep always announced ruſticity of manners. Demoſthenes reproaches Nicobulus for this very thing; and from the words he makes uſe of, it appears, that to ſpeak with inſolence and to walk haſtily were reckoned ſynonymous.

44 In the ſtatues of women.

In the figures of women, the artiſts have conformed to the principle obſerved in all the ancient tragedies, and recommended by Ariſtotle, never to make women ſhow too much intrepidity or exceſſive cruelty. Conformable to this maxim, Clytemneſtra is repreſented at a little diſtance from the fatal ſpot, watching the murderer, but without taking any part with him. In a painting of Timomachus repreſenting Medea and her children, when Medea lifts up the dagger they ſmile in her face, and her fury is immediately melted into compaſſion for the innocent victims. In another repreſentation of the ſame ſubject, Medea appears heſitating and indeciſive. Guided by the ſame maxims, the artiſts of moſt refined taſte were careful to avoid all deformity, chooſing rather to recede from truth than from their accuſtomed reſpect for beauty, as may be ſeen in ſeveral figures of Hecuba. Sometimes, however, ſhe appears in the decrepitude of age, her face furrowed with wrinkles, and her breaſts hanging down.

45 In the ſtatues of the Roman emperors.

Illuſtrious men, and thoſe inveſted with the offices of dignity, are repreſented with a noble aſſurance and firm aſpect. The ſtatues of the Roman emperors reſemble thoſe of heroes, and are far removed from every ſpecies of flattery, in the geſture, in the attitude, and action. They never appear with haughty looks, or with the ſplendor of royalty; no figure is ever ſeen preſenting any thing to them with bended knee, except captives; and none addreſſes them with an inclination of the head.

In

In modern works too little attention has been paid to the ancient *coſtume*. Winkelman mentions a bas-relief, which was lately executed at Rome for the fountain of Trevi, repreſenting an architect in the act of preſenting the plan of an aqueduct to Marcus Agrippa. The modern ſculptor, not content with giving a long beard to that illuſtrious Roman, contrary to all the ancient marble ſtatues as well as medals which remain, exhibits the architect on his knees.

In general, it was an eſtabliſhed principle to baniſh all violent paſſions from public monuments. This will ſerve as a deciſive mark to diſtinguiſh the true antique from ſuppoſititious works. A medal has been found exhibiting two Aſſyrians, a man and woman tearing their hair, with this inſcription, ASSYRIA. ET. PALAESTINA. IN POTEST. P. R. REDAC. S. C. The forgery of this medal is manifeſt from the word *Palaeſtina*, which is not to be found in any ancient Roman medal with a Latin inſcription. Beſides, the violent action of tearing the hair does not ſuit any ſymbolical figure. This extravagant ſtyle, which was called by the ancients *parenthyrſis*, has been imitated by moſt of the modern artiſts. Their figures reſemble comedians on the ancient theatres, who, in order to ſuit the diſtant ſpectators, put on painted maſks, employed exaggerated geſtures, and far overleaped the bounds of nature. This ſtyle has been reduced into a theory in a treatiſe on the paſſions compoſed by Le Brun. The deſigns which accompany that work exhibit the paſſions in the very higheſt degree, approaching even to frenzy: but theſe are calculated to vitiate the taſte, eſpecially of the young; for the ardour of youth prompts them rather to ſeize the extremity than the middle; and it will be difficult for that artiſt who has formed his taſte from ſuch empaſſioned models ever to acquire that noble ſimplicity and ſedate grandeur which diſtinguiſhed the works of ancient taſte.

46 Of proportions.

PROPORTION is the baſis of beauty, and there can be no beauty without it; on the contrary, proportion may exiſt where there is little beauty. Experience every day teaches us that knowledge is diſtinct from taſte; and proportion, therefore, which is founded on knowledge, may be ſtrictly obſerved in any figure, and yet the figure have no pretenſions to beauty. The ancients conſidering ideal beauty as the moſt perfect, have frequently employed it in preference to the beauty of nature.

The body conſiſts of three parts as well as the members. The three parts of the body are the trunk, the thighs, and the legs. The inferior parts of the body are the thighs, the legs, and the feet. The arms alſo conſiſt of three parts. Theſe three parts muſt bear a certain proportion to the whole as well as to one another. In a well formed man the head and body muſt be proportioned to the thighs, the legs, and the feet, in the ſame manner as the thighs are proportioned to the legs and the feet, or the arms to the hands. The face alſo conſiſts of three parts, that is, three times the length of the noſe; but the head is not four times the length of the noſe, as ſome writers have aſſerted. From the place where the hair begins to the crown of the head are only three-fourths of the length of the noſe, or that part is to the noſe as 9 to 12.

It is probable that the Grecian, as well as Egyptian artiſts, have determined the great and ſmall proportions by fixed rules; that they have eſtabliſhed a poſitive meaſure for the dimenſions of length, breadth, and circumference. This ſuppoſition alone can enable us to account for the great conformity which we meet with in ancient ſtatues. Winkelman thinks that the foot was the meaſure which the ancients uſed in all their great dimenſions, and that it was by the length of it that they regulated the meaſure of their figures, by giving to them ſix times that length. This in fact is the length which Vitruvius aſſigns, *Pes vero altitudinis corporis ſextæ*, lib. iii. cap. 1. That celebrated antiquary thinks the foot is a more determinate meaſure than the head or the face, the parts from which modern painters and ſculptors too often take their proportions. This proportion of the foot to the body, which has appeared ſtrange and incomprehenſible to the learned Huetius, and has been entirely rejected by Perrault, is however founded upon experience. After meaſuring with great care a vaſt number of figures, Winkelman found this proportion obſerved not only in Egyptian ſtatues, but alſo in thoſe of Greece. This fact may be determined by an inſpection of thoſe ſtatues the feet of which are perfect. One may be fully convinced of it by examining ſome divine figures, in which the artiſts have made ſome parts beyond their natural dimenſions. In the Apollo Belvidere, which is a little more than ſeven heads high, the foot is three Roman inches longer than the head. The head of the Venus de Medicis is very ſmall, and the height of the ſtatue is ſeven heads and a half: the foot is three inches and a half longer than the head, or preciſely the ſixth part of the length of the whole ſtatue.

PRACTICE OF SCULPTURE.

WE have been thus minute in our account of the Grecian ſculpture, becauſe it is the opinion of the ableſt critics that modern artiſts have been more or leſs eminent as they have ſtudied with the greater or leſs attention the models left us by that ingenious people: Winkelman goes ſo far as to contend that the moſt finiſhed works of the Grecian maſters ought to be ſtudied in preference even to the works of nature. This appears to be paradoxical; but the reaſon aſſigned by the Abbé for his opinion is, that the faireſt lines of beauty are more eaſily diſcovered, and make a more ſtriking and powerful impreſſion, by their reunion in theſe ſublime copies, than when they are ſcattered far and wide in the original. Allowing, therefore, the ſtudy of nature the high degree of merit it ſo juſtly claims, it muſt neverthe'eſs be granted, that it leads to true beauty by a much more tedious, laborious, and difficult path, than the ſtudy of the *antique*, which preſents immediately to the artiſt's view the object of his reſearches, and combines in a clear and ſtrong point of light the various rays of beauty that are diſperſed through the wide domain of nature. 47 Grecian ſculpture to be ſtudied by the modern artiſts.

As ſoon as the artiſt has laid this excellent foundation, acquired an intimate degree of familiarity with the beauties of the Grecian ſtatues, and formed his taſte after the admirable models they exhibit, he may then proceed with advantage and aſſurance to the imitation of nature. The ideas he has already formed of the perfection of nature, by obſerving her diſperſed beauties combined and collected in the compoſitions of the ancient artists, will enable him to acquire with facility, and to employ with advantage, the detached and partial ideas of beauty which will be exhibited to his view in a survey of nature in her actual state. When he discovers these partial beauties, he will be capable of combining them with those perfect forms of beauty with which he is already acquainted. In a word, by having always present to his mind the noble models already mentioned, he will be in some measure his own oracle, and will draw rules from his own mind.

48 Two ways of imitating nature.

There are, however, two ways of imitating nature. In the one a single object occupies the artist, who endeavours to represent it with precision and truth; in the other, certain lines and features are taken from a variety of objects, and combined and blended into one regular whole. All kinds of copies belong to the first kind of imitation; and productions of this kind must be executed necessarily in the Dutch manner, that is to say, with high finishing, and little or no invention. But the second kind of imitation leads directly to the investigation and discovery of true beauty, of that beauty whose idea is connate with the human mind, and is only to be found there in its highest perfection. This is the kind of imitation in which the Greeks excelled, and in which men of genius excite the young artists to excell after their example, *viz.* by studying nature as they did.

After having studied in the productions of the Grecian masters their choice and expression of select nature, their sublime and graceful contours, their noble draperies, together with that sedate grandeur and admirable simplicity that constitute their chief merit, the curious artists will do well to study the manual and mechanical part of their operations, as this is absolutely necessary to the successful imitation of their excellent manner.

49 Models of statues.

It is certain that the ancients almost always formed their first models in wax: to this modern artists have substituted clay, or some such composition: they prefer clay before wax in the carnations, on account of the yielding nature of the latter, and its sticking in some measure to every thing it touches. We must not, however, imagine from hence that the method of forming models of wet clay was either unknown or neglected among the Greeks; on the contrary, it was in Greece that models of this kind were invented. Their author was Dibutades of Sicyon; and it is well known that Arcesilas, the friend of Lucullus, obtained a higher degree of reputation by his clay models than by all his other productions. Indeed, if clay could be made to preserve its original moisture, it would undoubtedly be the fittest substance for the models of the sculptor; but when it is placed either in the fire or left to dry imperceptibly in the air, its solid parts grow more compact, and the figure losing thus a part of its dimensions, is necessarily reduced to a smaller volume. This diminution would be of no consequence did it equally affect the whole figure, so as to preserve its proportions entire. But this is not the case: for the smaller parts of the figure dry sooner than the larger; and thus losing more of their dimensions in the same space of time than the latter do, the symmetry and proportions of the figure inevitably suffer. This inconveniency does not take place in those models that are made in wax. It is indeed extremely difficult, in the ordinary method of working the wax, to give it that degree of smoothness that is necessary to represent the softness of the carnations or fleshy parts of the body. This inconvenience may, however, be remedied, by forming the model first in clay, then moulding it in plaster, and lastly casting it in wax. And, indeed, clay is seldom used but as a mould in which to cast a figure of plaster, stucco, or wax, to serve henceforth for a model by which the measures and proportions of the statue are to be adjusted. In making waxen models, it is common to put half a pound of colophony to a pound of wax; and some add turpentine, melting the whole with oil of olives.

50 Method of working the marble, and

So much for the first or preparatory steps in this procedure. It remains to consider the manner of working the marble after the model so prepared; and the method here followed by the Greeks seems to have been extremely different from that which is generally observed by modern artists. In the ancient statues we find the most striking proofs of the freedom and boldness that accompanied each stroke of the chisel, and which resulted from the artist's being perfectly sure of the accuracy of his idea, and the precision and steadiness of his hand: the most minute parts of the figure carry these marks of assurance and freedom; no indication of timorousness or diffidence appears; nothing that can induce us to fancy that the artist had occasion to correct any of his strokes. It is difficult to find, even in the second-rate productions of the Grecian artists, any mark of a false stroke or a random touch. This firmness and precision of the Grecian chisel were certainly derived from a more determined and perfect set of rules than those which are observed in modern times.

The method generally observed by the modern sculptor is as follows: First, out of a great block of marble he saws another of the size required, which is performed with a smooth steel saw, without teeth, casting water and sand thereon from time to time; then he fashions it, by taking off what is superfluous with a steel point and a heavy hammer of soft iron; after this, bringing it near the measure required, he reduces it still nearer with another finer point; he then uses a flat cutting instrument, having notches in its edge; and then a chisel to take off the scratches which the former has left; till, at length, taking rasps of different degrees of fineness, by degrees he brings his work into a condition for polishing.

After this, having studied his model with all possible attention, he draws upon this model horizontal and perpendicular lines which intersect each other at right angles. He afterwards copies these lines upon his marble, as the painter makes use of such transversal lines to copy a picture, or to reduce it to a smaller size. These transversal lines or squares, drawn in an equal number upon the marble and upon the model, in a manner proportioned to their respective dimensions, exhibit accurate measures of the surfaces upon which the artist is to work; but cannot determine, with equal precision, the depths that are proportioned to these surfaces.—The sculptor, indeed, may determine these depths by observing the relation they bear to his model; but as his eye is the only guide he has to follow in this estimate, he is always more or less exposed to error, or at least to doubt. He is never sure that the cavities made by by his chisel are exact; a degree of uncertainty accompanies each stroke; nor can he be assured that it has carried away neither too much nor too little of his marble. It is equally difficult to determine, by such lines as have already been mentioned, the external and internal contours of the figure, or to transfer them from the model to the marble. By the internal contour is understood that which is described by the parts which approach towards the centre, and which are not marked in a striking manner.

It is farther to be noticed, that in a complicated and laborious work, which an artist cannot execute without assistance, he is often obliged to make use of foreign hands, that have not the talents or dexterity that are necessary to finish his plan. A single stroke of the chisel that goes too deep is a defect not to be repaired; and such a stroke may easily happen, where the depths are so imperfectly determined. Defects of this kind are inevitable, if the sculptor, in chipping his marble, begins by forming the depths that are requisite in the figure he designs to represent. Nothing is more liable to error than this manner of proceeding. The cautious artist ought, on the contrary, to form these depths gradually, by little and little, with the utmost circumspection and care; and the determining of them with precision ought to be considered as the last part of his work, and as the finishing touches of his chisel.

51 Of copying ancient statues.

The various inconveniences attending this method determined several eminent artists to look out for one that would be liable to less uncertainty, and productive of fewer errors. The French academy of painting at Rome hit on a method of copying the ancient statues, which some sculptors have employed with success, even in the figures which they finished after models in clay or wax. This method is as follows. The statue that is to be copied is inclosed in a frame that fits it exactly. The upper part of this frame is divided into a certain number of equal parts, and to each of these parts a thread is fixed with a piece of lead at the end of it. These threads, which hang freely, show what parts of the statue are most removed from the centre with much more perspicuity and precision than the lines which are drawn on its surface, and which pass equally over the higher and hollow parts of the block: they also give the artist a tolerable rule to measure the more striking variations of height and depth, and thus render him more bold and determined in the execution of his plan.

But even this method is not without its defects: for as it is impossible, by the means of a straight line, to determine with precision the procedure of a curve, the artist has, in this method, no certain rule to guide him in his contours; and as often as the line which he is to describe deviates from the direction of the plumb line, which is his main guide, he must necessarily feel himself at a loss, and be obliged to have recourse to conjecture.

It is also evident, that this method affords no certain rule to determine exactly the proportion which the various parts of the figure ought to bear to each other, considered in their mutual relation and connections. The artist, indeed, endeavours to supply this defect by intersecting the plumb-lines by horizontal ones. This recourse has, nevertheless, its inconveniences, since the squares formed by transversal lines, that are at a distance from the figure (though they be exactly equal), yet represent the parts of the figure as greater or smaller, according as they are more or less removed from our position or point of view. But, notwithstanding these inconveniences, the method now under consideration is certainly the best that has hitherto been employed: it is more practicable and sure than any other we know, though it appears, from the remarks we have now been making, that it does not exhibit a sure and universal criterion to a sculptor who executes after a model.

52 Of polishing the statue.

To polish the statue, or make the parts of it smooth and sleek, pumice-stone and smelt are used; then tripoli; and when a still greater lustre is required, burnt straw is employed. For the *Casting of Statues*, see FOUNDERY, and *PLASTER of Paris*.

SCUM, properly denotes the impurities which a liquor, by boiling, casts up to the surface. The term *scum* is also used for what is more properly called the scoria of metals.

SCUPPERS, in a ship, are certain channels cut through the water-ways and sides of a ship, at proper distances, and lined with plated lead, in order to carry the water off from the deck into the sea. The scuppers of the lower deck of a ship of war are usually furnished with a leathern pipe, called the *scupper-hose*, which hangs downward from the mouth or opening of the scupper. The intent of this is to prevent the water from entering when the ship inclines under a weight of sail.

SCURVY, in *Medicine*, see that article, N° 351, where we have given an account of the symptoms, causes, and modes of prevention and cure, according to some of the most eminent writers in medicine. We have here only to add, that, in the opinion of Dr Beddoes, the mineral acids, especially the nitric and vitriolic, may be employed in the prevention or cure of this dreadful disease with as much success as the vegetable acids.—But of all the substances that can at once be cheaply procured and long preserved, he thinks the concrete acid of tartar by far the most promising. It is very grateful, and comes near to the citric acid. In tropical countries the scurvy is seldom known.

SCURVY-Grass. See COCHLEAREA, BOTANY *Index*.

SCUTAGE (*scutagium*, Sax. *scildpening*), was a tax or contribution raised by those that held lands by knights service, towards furnishing the king's army, at one, two, or three merks for every knight's fee. Henry III. for his voyage to the Holy Land, had a tenth granted by the clergy, and *scutage*, three merks of every knight's fee by the *laity*. This was also levied by Henry II. Richard I. and King John. See *KNIGHT-Service*.

SCUTE (*scutum*), a French gold coin of 3s. 4d. in the reign of King Henry V. Catharine queen of England had an assurance made her of sundry castles, manors, lands, &c. valued at the sum of 40,000 *scutes*, every

every two whereof were worth a noble. *Rot. Parl.* 1. *Hen.* VI.

SCUTELLARIA, Skull-cap, a genus of plants, belonging to the didynamia class; and in the natural method ranking under the 40th order, *Personatæ*. See Botany *Index*.

SCUTTLES, in a ship, square holes cut in the deck, big enough to let down the body of a man, and which serve upon some occasions to let the people down into any room below, or from one deck to another.

SCYLAX, a celebrated mathematician and geographer of Caria, flourished under the reign of Darius Hystaspes, about 558 B. C. Some have attributed to him the invention of geographical tables. We have under his name a geographical work published by Hoeschelius; but it is written by a much later author, and is perhaps only an abridgement of Scylax's Ancient Geography.

SCYLLA, in *Ancient Geography*, a rock in the Fretum Siculum, near the coast of Italy, dangerous to shipping, opposite to Charybdis, a whirlpool on the coast of Sicily; both of them famous in mythology.

Sutherland's Tour up the Straits, Letter xii. Scylla and Charybdis have been almost subdued by the repeated convulsions of this part of the earth, and by the violence of the current, which is continually increasing the breadth of the straits. If proper allowance be made for these circumstances, we shall acquit the ancients of any exaggeration, notwithstanding the very dreadful colours in which they have painted this passage. It is formed by a low peninsula, called *Cape Pelorus*, stretching to the eastward on the Sicilian side, immediately within which lies the famous whirlpool of Charybdis, and by the rocks of Scylla, which a few miles below on the Calabrian shore project towards the west. The current runs with surprising force from one to the other alternately in the direction of the tide, and the tides themselves are very irregular. Thus vessels, by shunning the one, were in the utmost danger of being swallowed up by the other.

At present, in moderate weather, when the tide is either at ebb or flood, boats pass all over the whirlpool: but, in general, it is like the meeting of two contending currents, with a number of eddies all around; and, even now, there is scarcely a winter in which there are not some wrecks.

"At the time when we passed the straits (says Captain Sutherland, from whom we have obtained this accurate information) the weather was as favourable as we could wish; and yet, in spite of a strong breeze and the current, which hurried us on with surprising velocity, the ship's head was suddenly whirled round near three points; but the wind blowing fresh, in a few seconds she dashed through the eddy that had caught her; for, to avoid Scylla, and secure Messina, we had kept pretty close to Charybdis." For a later account of these rocks, see Sicily.

SCYROS, an island in the Ægean sea, at the distance of about 28 miles north-east from Eubœa. It is 60 miles in circumference. It was originally in the possession of the Pelasgians and Carians. Achilles retired there to avoid going to the Trojan war, and became father of Neoptolemus by Deidamia the daughter of King Lycomedes. Scyros was conquered by the Athenians under Cimon. It was very rocky and barren. Now *Sciro*. E. Long. 25. 0. N. Lat. 38. 15.

SCYTALA Laconica, in antiquity, a stratagem or device of the Lacedemonians, for the secret writing of letters to their correspondents, so that if they should chance to be intercepted, nobody might be able to read them.—To this end they had two wooden rollers or cylinders, perfectly alike and equal; one whereof was kept in the city, the other by the person to whom the letter was directed. For the letter, a skin of very thin parchment was wrapped round the roller, and thereon was the matter written; which done, it was taken off, and sent away to the party, who, upon putting it in the same manner upon his roller, found the lines and words in the very same disposition as when they were first written. This expedient they set a very high value on; though, in truth, artless and gross enough: the moderns have improved vastly on this method of writing. See Cipher.

SCYTALIA, a genus of plants belonging to the octandria class; and in the natural method ranking with those that are doubtful. See Botany *Index*.

SCYTHE, in *Husbandry*, a well known instrument which has been long employed for cutting grass for hay. The same instrument with certain modifications in its construction has been used in reaping grain, in place of the sickle the use of which is far more common, and in Scotland at least prevails almost universally, although it must be admitted that the method of reaping by the scythe, where it is practicable, is attended with less labour, is more expeditious, and therefore more economical. But against the use of the scythe, as a reaping instrument, many objections have been raised. Some of these are probably founded in prejudice, while others, considering the slow progress which has been made in introducing this instrument as a substitute for the sickle, rest on a more solid foundation.

It is said that this instrument shakes the ear, so that many of the grains are lost; that it lets the corn fall after it is cut, in a scattered confused manner, in consequence of which either a great deal of it is lost, or much time is wasted in gathering it together. It is also affirmed that it can only be made use of in very even land, and which is free from stones; that it does not leave length enough of stubble on the ground, on which to lay the corn when it is cut; that it mixes noxious weeds with the corn, the seeds of which are sown the ensuing year; and finally, that the use of the scythe is prejudicial to the health of the reaper.

It appears, however, that these objections have either no weight, or they are made by those who are unacquainted with the scythes peculiarly adapted to this purpose, and with the manner in which they ought to be used. With a good scythe properly managed, the corn when cut, remains at first upright, afterwards falling gently on the rake fixed to the scythe, without any shaking or jolting, or at least with less than what is occasioned by the sickle. The loss of grain chiefly arises from the corn being too dry, and therefore it ought to be reaped on proper days, and suitable times of the day, which is more easily accomplished by the scythe than the sickle, because the one requires less time than the other. The stalks, held together by the rake, may be laid on the ground, or against the corn not yet cut down, in a state so regular and connected, that those by whom the sheaves are collected and bound have themselves alone to blame, should any thing be left behind. It is sufficiently even when lands are ploughed and harrowed

 rowed in a proper manner; and the only neceſſary precaution in ſtony ground, is to keep the ſcythe a little higher, that it may not ſtrike againſt the ſtones. If the ſtubble be ſhort, the ſtraw cut off will of courſe be the longer, and of conſequence more valuable; and long ſtubble only incommodes the cattle afterwards ſent to feed upon it.

Theſe and ſimilar conſiderations, prevailed with the patriotic ſociety of Milan, to ſend to theſe places where ſcythes are uſed for reaping; and having procured a model from Sileſia, they ordered one of a proper ſize to be made. It was firſt tried on corn, and afterwards on millet; and notwithſtanding the firſt was far from being made with accuracy, and although ſuch an inſtrument had never before been made uſe of by the reaper, nearly half the uſual time was found to be ſaved, and the wonted fatigue and labour were much diminiſhed. The corn was cut without receiving any injurious ſhock, falling in an even and regular ſtate, by which means it was afterwards bound up with eaſe in compact ſheaves.

Plate cccclxxviii. Fig. 1. These inſtruments are ſo ſimple in their conſtruction, that a figure of one of them renders a deſcription almoſt unneceſſary. Fig. 1. repreſents the Sileſian ſcythe tried by the ſociety, the difference between which and the Auſtrian one we ſhall mention in our deſcription. The Sileſian ſcythe differs little from that commonly employed in mowing graſs, except that the blade is rather ſmaller; to it four teeth of wood are added, parallel to the blade, fixed and ſecured in a proper manner, and deſigned to keep the corn together after it is cut; ſo that inſtead of its falling in a confuſed ſtate, the reaper can lay it down in a regular and compact manner. The Auſtrian ſcythe is ſimilar to the former, but the blade is larger; of courſe the wooden teeth, being five in number, are longer; the handle is alſo flatter, and rather crooked.

In the firſt, the handle *a b* (ſee fig. 1.) is four feet three inches in length; the blade *bc* is about two feet; the piece of wood in which the teeth are fixed, one foot ten inches and a half. In the *ſecond*, the handle is four feet one inch; the blade, two feet eight inches; the piece in which the teeth are fixed, $11\frac{1}{2}$ inches.

The difference in the conſtruction of theſe two ſcythes renders it neceſſary to uſe them in a different manner, which will be better acquired in practice than by precept. Such as are accuſtomed to the uſe of the common ſcythe will ſoon find out the moſt advantageous manner of uſing theſe new kinds of ſcythes, and of laying down the corn properly after it is cut.

It is neceſſary to obſerve, that, in mowing graſs, the feet are held in a poſition nearly parallel to each other, whereas in reaping corn they ſhould be kept on a line, the one behind the other, bringing the right foot forward, and drawing the left towards it. The reaſon is, that when graſs is mowed it is left to fall where it is cut; but when corn is cut down, it is to be laid in a proper manner againſt that which is not yet cut, and which is at the reaper's left hand. Were the feet kept parallel to each other, the reaper would be under the neceſſity of extending and turning his body in a very inconvenient manner.

Theſe obſervations having been publiſhed, the ſociety made farther experiments on the ſubject, by which they diſcovered, that when the ſtalks of corn are bent down by reaſon of extremely wet weather, the wooden teeth of the ſcythes are apt to lay hold of ſome ears, to the ſtalks of which the iron does not extend; and therefore theſe not being cut below, are pulled ſo that the grain is ſcattered. This chiefly happens from the reapers not being accuſtomed to that kind of ſcythe, and therefore not knowing how to adapt it to particular exiſting circumſtances.

It occurred to an ingenious blackſmith, that, in order to remedy this inconvenience, a *collector* made of cloth ſhould be added to the common ſcythe, as may be ſeen at fig. 2. where *abc* is a common ſcythe, *cdmloſne* is the gatherer, which at *c d e* is compoſed of a thin plate of iron, having a hollow at its extremity for receiving the point of the blade. At *e d* are holes for ſewing in the cloth, which is coarſe, light, and of low price; it is alſo fixed to two thick iron wires, of which the upper one is continued to *f*, where it terminates in a hole in the handle; the other is fixed to the back of the blade. The manner of fixing this gatherer to the back of the ſcythe will be better underſtood by referring to fig. 3. which repreſents one of the irons which, by means of the ſcrew, are faſtened to the back of the ſcythe. Theſe proceed from, and make part of the upright irons *m n*, *l o*, which ſerve to keep the gatherer extended. Fig. 2. Fig. 3.

This contrivance is both cheap and ſimple; but an attempt was made to render it more ſo, by ſubſtituting two iron hoops for the gatherer, which are ſhewn in fig. 2. by the dotted lines *h g*, *k i*, with a croſs piece *p*, which connects them. Experience has ſhewn, however, that the gatherer is in general preferable to theſe hoops, as it does not leave an ear of corn behind. Fig. 2.

SCYTHIA, an ancient name for the northern parts of Aſia, now known by the name of *Tartary;* alſo for ſome of the north-eaſtern parts of Europe.

This vaſt territory, which extends itſelf from the Iſter or Danube, the boundary of the Celts, that is, from about the 25th to almoſt the 110th degree of eaſt longitude, was divided into Scythia in Europe and Scythia in Aſia, including, however, the two Sarmatias; or, as they are called by the Greeks, *Sauromatias*, now the Circaſſian Tartary, which lay between and ſevered the two Scythias from each other. Sauromatia was alſo diſtinguiſhed into European and Aſiatic; and was divided from the European Scythia by the river Don or Tanais, which falls into the Palus Meotis; and from the Aſiatic by the Rha, now Volga, which empties itſelf into the Caſpian ſea.

1. The Aſiatic Scythia comprehended, in general, great Tartary, and Ruſſia in Aſia; and, in particular, the Scythia beyond or without Imaus, contained the regions of Bogdoi or Oſtiacoi, and Tanguti. That within, or on this ſide Imaus, had Turkeſtan and Mongal, the Uſbeck or Zagatai, Kalmuc and Nagaian Tartars; beſides Siberia, the land of the Samoiedes, and Nova Zembla. Theſe three laſt not being ſo ſoon inhabited as the former, as may be reaſonably ſuppoſed, were wholly unknown to the ancients; and the former were peopled by the Bactrians, Sogdians, Gandari, Sacks, and Maſſagetes. As for Sarmatia, it contained Albania, Iberia, and Colchis; which makes now the Circaſſian Tartary, and the province of Georgia.

2. Scythia in Europe reached (towards the ſouth-weſt) to the Po and the Alps, by which it was divided from Celto-Gallia. It was bounded on the ſouth by the

the Iſter or Danube and the Euxine ſea. Its northern limits have been ſuppoſed to ſtretch to the ſpring-heads of the Boriſthenes or Nieper, and the Rha or Volga, and ſo to that of the Tanais.—The ancients divided this country into Scythia Arimaſpæa, which lay eaſtward, joining to Scythia in Aſia; and Sarmatia Europeana on the weſt. In Scythia, properly ſo called, were the Arimaſpæi on the north; the Getæ or Dacians along the Danube, on the ſouth; and the Neuri between theſe two. So that it contained the European Ruſſia or Muſcovy, and the Leſſer Crim Tartary eaſtward; and, on the weſt, Lithuania, Poland, part of Hungary, Tranſilvania, Walachia, Bulgaria, and Moldavia. Sarmatia is ſuppoſed to have reached northward to that part of Swedeland called *Feningia*, now *Finland;* in which they placed the Oœnes, Panoti, and Hippopodes. This part they divided from Northern Germany, now the weſt part of Sweden and Norway, by the *Mare Sarmaticum* or *Scythicum*, which they ſuppoſed ran up into the northern ocean, and, dividing Lapland into two parts, formed the weſtern part of Sweden, with Norway, into one iſland, and Finland into another; ſuppoſing this alſo to be cut off from the continent by the gulf of that name.

Although the ancient Scythians were celebrated as a warlike people, yet their hiſtory is too uncertain and obſcure to enable us to give any detail which would not prove equally tireſome and unintereſting to the reader. Mr Pinkerton, in a diſſertation on their origin, endeavours to prove that they were the moſt ancient of nations; and he aſſigns for the place of their firſt habitation the country known by the name of Perſia. From Perſia, he thinks, they proceeded in numerous hordes weſtward, ſurrounded the Euxine, peopled Germany, Italy, Gaul, the countries bordering on the Baltic, with part of Britain and Ireland. That the Scythians were of Aſiatic origin cannot, we think, be queſtioned; and as Perſia was peopled at a very early period, it may not improbably have been their parent country: but when our author contends that their empire had ſubſiſted for more than 1500 years before Ninus the founder of the Aſſyrian monarchy, and that it extended from Egypt to the Ganges, and from the Perſian gulf and Indian ſea to the Caſpian, we cannot help thinking that his prejudices againſt the Celts, and his deſire to do honour to his favourite Goths, have made him advance a paradox inconſiſtent with the moſt authentic records of antiquity. His diſſertation however is ingenious, and replete with a variety of curious learning.

SCYTHIAN Lamb, in *Natural Hiſtory*. See *Scythian LAMB*.

SCYTHROPS, or CHANNEL-BILL, a genus of birds belonging to the order of Picæ. See ORNITHOLOGY, N° 149.

SEA, in a ſtrict ſenſe, ſignifies a large portion of water almoſt ſurrounded by land, as the Baltic and Mediterranean ſeas; but it is frequently uſed for that vaſt body of water which encompaſſes the whole earth.

1 What proportion the ſurface of the ſea bears to that of the land.

What proportion the ſuperficies of the ſea bears to that of the land cannot eaſily be aſcertained. Buffon has ſuppoſed that the ſurface of our globe is equally divided between land and water, and has accordingly calculated the ſuperficies of the ſea to be 85,490,506 ſquare miles. But it is now well known that the ocean covers much more than the half of the earth's ſurface. Buffon believed the exiſtence of a vaſt ſouthern continent, which Captain Cook has ſhown to be viſionary. It was this circumſtance which miſled him. According to the moſt accurate obſervations hitherto made, the ſurface of the ſea is to the land as three to one; the ocean therefore extends over 128,235,759 ſquare miles, ſuppoſing the ſuperficies of the whole globe to be 170,981,012 ſquare miles.

2 Depth of the ſea.

To aſcertain the depth of the ſea is ſtill more difficult than its ſuperficies, both on account of the numerous experiments which it would be neceſſary to make, and the want of proper inſtruments for that purpoſe. Beyond a certain depth the ſea has hitherto been found unfathomable; and though ſeveral methods have been contrived to obviate this difficulty, none of them has completely anſwered the purpoſe. We know in general that the depth of the ſea increaſes gradually as we leave the ſhore; but if this continued beyond a certain diſtance, the depth in the middle of the ocean would be prodigious. Indeed the numerous iſlands everywhere ſcattered in the ſea demonſtrate the contrary, by ſhowing us that the bottom of the water is unequal like the land, and that ſo far from uniformly ſinking, it ſometimes riſes into lofty mountains. If the depth of the ſea be in proportion to the elevation of the land, as has generally been ſuppoſed, its greateſt depth will not exceed five or ſix miles, for there is no mountain ſix miles perpendicular above the level of the ſea. The ſea has never been actually ſounded to a greater depth than a mile and 66 feet; every thing beyond that therefore reſts entirely upon conjecture and analogical reaſoning, which ought never to be admitted to determine a ſingle point that can be aſcertained by experiment, becauſe, when admitted, they have too often led to falſe concluſions. Along the coaſts, where the depth of the ſea is in general well known, it has always been found proportioned to the height of the ſhore: when the coaſt is high and mountainous, the ſea that waſhes it is deep; when, on the contrary, the coaſt is low, the water is ſhallow. Whether this analogy holds at a diſtance from the ſhore, experiments alone can determine.

3 Quantity of water which it contains.

To calculate the quantity of water contained in the ſea, while its depth is unknown, is impoſſible. But if we ſuppoſe with Buffon that its medium depth is the fourth part of a mile, the ocean, if its ſuperficies be 120,235,759 ſquare miles, will contain 32,058,939.75 cubic miles of water.

Buffon's Theory of the Earth, art. 10.

Let us now endeavour to compute the quantity of water which is conſtantly diſcharged into the ſea. For this purpoſe let us take a river whoſe velocity and quantity of water is known, the Po, for inſtance, which according to Riccioli is 1000 feet (or 100 perches of Bologna) broad, 10 feet deep, and runs at the rate of four miles in an hour; conſequently that river diſcharges into the ſea 200,000 cubic perches of water in an hour, or 4,800,000 in a day. A cubic mile contains 125,000,000 cubic perches; the Po therefore will take 26 days to diſcharge a cubic mile of water into the ſea. Let us now ſuppoſe, what is perhaps not very far from the truth, that the quantity of water which the ſea receives from the rivers in any country is proportioned to the extent of that country. The Po from its origin to its mouth traverſes a country 380 miles long, and the rivers which fall into it on every ſide riſe from ſources about ſixty miles diſtant from it.

The

The Po, therefore, and the rivers which it receives, water a country of 45,600 ſquare miles. Now ſince the whole ſuperficies of the dry land is about 42,745,253 ſquare miles, it follows, from our ſuppoſition, that the quantity of water diſcharged by all the rivers in the world, in one day, is 36 cubic miles, and in a year 13,140. If therefore the ſea contains 32,058,939 cubic miles of water, it would take all the rivers in the world 2439 years to diſcharge an equal quantity.

4
Why it does not increaſe.

It may ſeem ſurpriſing that the ſea, ſince it is continually receiving ſuch an immenſe ſupply of water, does not viſibly increaſe, and at laſt cover the whole earth. But our ſurpriſe will ceaſe, if we conſider that the rivers themſelves are ſupplied from the ſea, and that they do nothing more than carry back thoſe waters which the ocean is continually laviſhing on the earth. Dr Halley has demonſtrated that the vapours raiſed from the ſea and tranſported on land are ſufficient to maintain all the rivers in the world. The ſimplicity of this great proceſs is aſtoniſhing: the ſea not only connects diſtant countries, and renders it eaſy to tranſport the commodities of one nation to another, but its waters riſing in the air deſcend in ſhowers to fertilize the earth and nouriſh the vegetable kingdom, and collecting into rivers flow onwards, bringing fertility and wealth and commerce along with them, and again return to the ſea to repeat the ſame round.

5
Theories of philoſophers on this ſubject.

The knowledge of this proceſs of nature might, one would think, have convinced philoſophers that the proportion between ſea and land continued always nearly the ſame. Philoſophers however have formed different theories about this as well as moſt other ſubjects, maintaining on the one hand that the ſea is continually encroaching on the land, and on the other that the land is conſtantly gaining on the ſea. Both ſides have ſupported their theories by arguments, demonſtrations, and incontrovertible facts!

6
Arguments of thoſe who affirm that the ſea is encroaching on the land.

The height of the mountains, ſay the philoſophers who ſupport the encroachments of the ſea, is continually diminiſhing; expoſed to the violence of every ſtorm, the hardeſt rocks muſt at laſt give way and tumble down. The rivers are continually ſweeping along with them particles of earth which they depoſite in the bottom of the ſea. Both the depth of the ocean then and the height of the dry land muſt be always decreaſing; the waters therefore muſt, unleſs a part of them were annihilated, ſpread over a greater extent of ſurface in proportion as theſe cauſes operate. This reaſoning, convincing as it is, might be confirmed by a great number of facts: it will be ſufficient however to mention one or two. In the reign of Auguſtus the iſle of Wight made a part of Britain, ſo that the Engliſh croſſed over to it at low water with cart loads of tin; yet that iſland is at preſent ſeparated from Britain by a channel half a mile wide. The Godwin ſands on the eaſtern ſhore of England were formerly the fertile eſtate of earl Godwin. Nor are the encroachments of the ſea confined to Britain. In the bay of Baiæ near Naples there are remains of houſes and ſtreets ſtill viſible below the preſent level of the ſea. The ſea therefore is making continued encroachments upon the land; and the time will come, ſay they, when the waters will again cover the ſurface of the earth.

Such are the arguments of thoſe philoſophers who maintain the continual encroachments of the ſea. Thoſe who maintain the oppoſite theory, that the land is gradually gaining on the ſea, though they pretend not to deny the facts advanced by their opponents, affirm that they are altogether inſufficient to eſtabliſh the hypotheſis which they were brought forward to ſupport.

7
Arguments of thoſe who affirm that the land is gaining on the ſea.

Though the rivers carry down particles of earth into the ſea, theſe, ſay they, are either accumulated on other ſhores, or, collecting in the bottom of the ocean, harden into ſtone, which being poſſeſſed of a vegetative power riſes by degrees above the ſurface of the ſea and forms rocks, and mountains, and iſlands. The vegetative nature of ſtone indeed is ſufficient, of itſelf, to convince us that the quantity of earth muſt be daily accumulating, and conſequently that the ſurface of the ſea is diminiſhing in extent. Celſius, a Swediſh philoſopher (for this diſpute has been carried on in Sweden with the greateſt keenneſs), has endeavoured to build this theory with more ſolid materials than vegetable ſtone. In a curious memoir, publiſhed in 1743, he aſſerts that the Baltic and the Atlantic, at leaſt that part of it which waſhes Norway, is conſtantly diminiſhing; and he proves this by the teſtimony of a great many aged pilots and fiſhermen, who affirmed that the ſea was become much ſhallower in many places than it had been during their youth: that many rocks formerly covered with water were now ſeveral feet above the ſurface of the ſea: that loaded veſſels uſed formerly to ride in many places where pinnaces and barks could now with difficulty ſwim. He produces inſtances of ancient ſea-port towns now ſeveral leagues from the ſhore, and of anchors and wrecks of veſſels found far within the country. He mentions a particular rock which 168 years before was at the bottom of the ſea, but was then raiſed eight feet above its ſurface. In another place where the water 50 years before had reached to the knee there was then none. Several rocks, too, which during the infancy of ſome old pilots had been two feet under water, were then three feet above it. From all theſe obſervations M. Celſius concludes, that the water of the Baltic decreaſes in height $4\frac{1}{2}$ lines in a year, 4 inches 5 lines in 18 years, 4 feet 5 inches in a hundred years, and in a thouſand years 45 feet. Conſcious, however, that theſe facts, how concluſive ſoever as far as relates to the Baltic, can never determine the general queſtion, M. Celſius advances another argument in ſupport of his theory. All that quantity of moiſture, ſays he, which is imbibed by plants is loſt to the general maſs of water, being converted into earth by the putrefaction of vegetables. This notion had been mentioned by Newton, and was adopted by Van Helmont: if granted, it follows as a conſequence that the earth is continually increaſing and the water diminiſhing in a very rapid degree.

8
Theſe arguments examined.

Such are the arguments advanced in ſupport of both theories; for it is needleſs to mention a notion of Linnæus that the whole earth was formerly covered with water except a ſingle mountain. When fairly weighed, they amount to nothing more than this, that the ſea has encroached upon the land in ſome places, and retired in others; a concluſion which we are very willing to allow. What was advanced by thoſe philoſophers who maintain that the ſea is continually encroaching on the land, about the depth of the ſea conſtantly diminiſhing, muſt remain a mere aſſertion till they prove by experiments, either that this is really the caſe, or that nature has no way of reſtoring thoſe particles of earth

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earth which are waſhed down by the rivers. Nor have they any good reaſon to affirm that the height of the mountains is decreaſing. Can a ſingle uncontrovertible inſtance be produced of this? Are the Alps or the Apennines, or Taurus, or Caucaſus, leſs lofty now than they were a thouſand years ago? We mean not to deny that the rain actually waſhes down particles of earth from the mountains, nor to affirm that the hardeſt rocks are able to reſiſt continual ſtorms, nor that many mountains have ſuffered, and continue to ſuffer daily, from a thouſand accidents. But the effects produced by all theſe cauſes are ſo trifling as to be altogether imperceptible (A). Nature has aſſiduouſly guarded againſt ſuch accidents; ſhe has formed the mountains of the moſt durable materials; and where they are covered with earth, ſhe has bound it together by a thick and firm matting of graſs, and thus ſecured it from the rains; and ſhould accident deprive it of this covering, ſhe takes care immediately to ſupply the defect. Even ſhould the earth be ſwept away together with its covering, nature has ſtill ſuch reſources left as frequently reſtore things to their former ſtate. Many kinds of moſs, one would be tempted to think, have been created for this very purpoſe: they take root and flouriſh almoſt upon the bare rock, and furniſh as they decay a ſufficient bed for ſeveral of the hardy Alpine plants. Theſe periſh in their turn, and others ſucceed them. The roots of the plants bind faſt the earth as it accumulates, more plants ſpring up and ſpread wider, till by degrees the whole ſurface is covered with a firm coat of graſs.

9 Bottom of the ſea.

As the ſea covers ſo great a portion of the globe, we ſhould, no doubt, by exploring its bottom, diſcover a vaſt number of intereſting particulars. Unfortunately in the greater part of the ocean this has hitherto been impoſſible. Part, however, has been examined; and the diſcoveries which this examination has produced may enable us to form ſome idea at leaſt of the whole. The bottom of the ſea, as might have been conjectured indeed beforehand, bears a great reſemblance to the ſurface of the dry land, being, like it, full of plains, rocks, caverns and mountains; ſome of which are abrupt and almoſt perpendicular, while others riſe with a gentle declivity, and ſometimes tower above the water and form iſlands. Neither do the materials differ which compoſe the bottom of the ſea and the baſis of the dry land. If we dig to a conſiderable depth in any part of the earth, we uniformly meet with rock; the ſame thing holds in the ſea. The ſtrata, too, are of the ſame kind, diſpoſed in the ſame manner, and form indeed but one whole. The ſame kind of mineral and bituminous ſubſtances are alſo found interſperſed with theſe ſtrata; and it is to them probably that the ſea is indebted for its bitter taſte. Over theſe natural and original ſtrata an artificial bed has pretty generally been formed, compoſed of different materials in different places. It conſiſts frequently of muddy tartareous ſubſtances firmly cemented together, ſometimes of ſhells or coral reduced to powder, and near the mouths of rivers it is generally compoſed of fine ſand or gravel. The bottom of the ſea reſembles the land likewiſe in another particular: many freſh ſprings and even rivers riſe out of it, which, diſplacing the ſalt water, render the lower part of the ſea wherever they abound quite freſh. An inſtance of this kind occurs near Goa on the weſtern coaſt of Indoſtan *, and another † in the Mediterranean ſea not far from Marſeilles. Theſe facts occaſioned a notion, which later experiments have exploded, that the ſea beyond a certain depth was always freſh.

* *Boyle de Fundo Maris.*
† *Marſigli Hiſtoire Phyſique de la Mer,* partie 1.

Subſtances of a very beautiful appearance are frequently brought up by the ſounding line from the bottom of the ſea. The plummet is hollowed below, and this cavity filled with tallow, to which ſome of the ſubſtances adhere which form the bed of the ocean. Theſe are generally ſand, gravel, or mud; but they are ſometimes of the brighteſt ſcarlet, vermilion, purple, and yellow; and ſometimes, though leſs frequently, they are blue, green, or white. Theſe colours are owing to a kind of jelly which envelopes the ſubſtances, and vaniſh entirely as ſoon as this jelly dries. At times, however, they aſſume the appearance of tartareous cruſts, and are then ſo permanent, that they can be received into white wax melted and poured round them, and perhaps by proper care might be converted into valuable paints.

10 Colour of the ſea.

Sea-water is really, as any one may convince himſelf by pouring it into a glaſs, as clear and tranſparent as river water. The various appearances therefore which it aſſumes are owing to accidental cauſes, and not to any change in the water itſelf. The depth, or the materials which compoſe the bottom of the ſea, occaſions it to aſſume different colours in different places. The Arabian gulf, for inſtance, is ſaid to be red from the colour of the ſands which form its bed. The appearance of the ſea is affected too by the winds and the ſun, while the clouds that paſs over it communicate all their various and fleeting colours. When the ſun ſhines it is green; when the ſun gleams through a fog it is yellow; near the north pole it appears black; while in the torrid zone its colour is often brown. Sometimes the ſea aſſumes a luminous appearance. See LIGHT, Vol. XII. page 2.

11 Saltneſs of the ſea.

The ſea contains the greateſt quantity of ſalt in the torrid zone, where otherwiſe from the exceſſive heat it would be in danger of putrefaction: as we advance northward this quantity diminiſhes, till at the pole it nearly vaniſhes altogether. Under the line Lucas found that the ſea contained a ſeventh part of ſolid contents, conſiſting chiefly of ſea-ſalt. At Harwich he found it yielded $\frac{1}{25}$th of ſea-ſalt. At Carlſcroon in Sweden it contains $\frac{1}{70}$th part (B), and on the coaſt of Greenland a great deal leſs. This deficiency of ſalt near the poles probably contributes a good deal towards the prodigious

(A) M. Genſanne pretends that the Pyrenean mountains become an inch lower every ten years. But even according to his own calculation, it would require a million of years to level theſe mountains with the plain, though they continued to decreaſe at the ſame rate; and philoſophers tell us that this rate is conſtantly diminiſhing!

(B) This gradual diminution of ſaltneſs from the equator to the pole is not, however, without particular exceptions. The Mediterranean ſea contains $\frac{1}{27}$th of ſea-ſalt, which is leſs than the German ſea contains.

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ous quantities of ice which are met with in theſe ſeas; for ſalt water requires a much greater degree of cold to freeze it than freſh water. It was this circumſtance, probably, together with its conſtant motion, which induced the ancients to believe that the ſea never froze. Even among the moderns it has been a generally received opinion, that ſea-ice is originally formed in rivers. Buffon has made the great quantities of ice with which the South ſea abounds an argument for the exiſtence of a continent near the Antarctic pole. But it is now well known that great quantities of ice are formed at a diſtance from land. Sea-ice is of two kinds; field ice, which extends along the ſhore, and is only two or three feet thick; and mountain ice, which abounds in the middle of the ocean. The ſize of theſe mountains is ſometimes prodigious. The ſea-ice is always freſh, and has been often of great uſe to navigators. The weight of ſea-water is to that of river-water as 73 to 70; that is, a cubic foot of ſea-water weighs 73lb. while the ſame quantity of river-water weighs only 70lb.; but this proportion varies in different places. It is worthy of our attention, too, that the water at the ſurface of the ſea contains leſs ſalt than near the bottom; the difference indeed is inconſiderable, but ſtill it is ſomething. The Compte de Marſigli found the ſame quantity of water, when taken from the bottom of the Mediterranean, to weigh one ounce three pennyweights 51 grains; whereas from the ſurface it weighed only one ounce three pennyweights 49 grains. He repeated the experiment frequently with nearly the ſame reſult.

12 Temperature of the ſea.

The ſea, with reſpect to temperature, may be divided into two regions: The firſt begins at the ſurface of the water, and deſcends as far as the influence of the ſun's rays; the ſecond reaches from thence to the bottom of the ſea. In ſummer the lower region is conſiderably colder than the upper: but it is probable that during winter the very reverſe takes place; at leaſt the Compte de Marſigli found it ſo repeatedly in the Mediterranean. This naturally reſults from the ſituation of the water near the bottom of the ſea. Uninfluenced by the changes in the atmoſphere, it retains always nearly the ſame degree of temperature: and this is conſiderably above congelation; for the lower region of the ſea, at leaſt in the temperate parts of the world, was never known to freeze. Captain Ellis let down a ſea-gage (ſee GAGE) in latitude 25° 13′ north, and longitude 25° 12′ weſt, to take the degrees of temperature and ſaltneſs of the ſea at different depths. It deſcended 5346 feet, which is a mile and eleven fathoms. He found the ſea ſalter and colder in proportion to its depth till the gage had deſcended 3900 feet, when the mercury in the thermometer came up at 53; but the water never grew colder, though he let down the gage 2446 feet lower. At the ſurface the thermometer ſtood at 84.

Boyle de Temperie Regionum Submarinarum.

Phil. Tranſ. for 1771, p. 213.

13 The ſea has three motions. Motion occaſioned by the wind

The ſea has three kinds of motion: 1. The firſt is that undulation which is occaſioned by the wind. This motion is entirely confined to the ſurface; the bottom even during the moſt violent ſtorms remains perfectly calm. Mr Boyle has remarked, from the teſtimony of ſeveral divers, that the ſea is affected by the winds only to the depth of ſix feet. It would follow from this, that the height of the waves above the ſurface does not exceed ſix feet; and that this holds in the Mediterranean at leaſt, we are informed by the Compte de Marſigli, though he alſo ſometimes obſerved them, during a very violent tempeſt, riſe two feet higher. It is affirmed by Pliny, and ſeveral other ancient writers, that oil calms the waves of the ſea; and that divers were accuſtomed to carry ſome of it for that purpoſe in their mouths. This account was always conſidered by the moderns as a fable, and treated with ſuch contempt, that they did not even deign to put it to the teſt of experiment, till Dr Franklin accidentally diſcovered its truth. Happening in 1757 to be in the middle of a large fleet, he obſerved that the water round one or two veſſels was quite calm and ſmooth, while everywhere elſe it was very much agitated by the winds. He applied to the captain for an explanation of this phenomenon, who replied, that the cooks, he ſuppoſed, had thrown their greaſy water out at the ſcupper-holes, and by that means oiled the ſides of the veſſels in queſtion. This anſwer did not ſatisfy the Doctor at firſt; but recollecting what Pliny had ſaid on the ſubject, he reſolved at leaſt to make the experiment. He did ſo accordingly in 1762, and found that oil actually calmed the waves of the ſea. He repeated the experiment upon a pond at Clapham: the oil ſpread itſelf with great rapidity upon the ſurface, but did not produce the deſired effect, becauſe, having been thrown in upon the ſide oppoſite to the wind, it was immediately driven to the edge of the water. But upon throwing in a like quantity upon the other ſide of the lake, it calmed in an inſtant ſeveral yards of the ſurface; and gradually ſpreading, rendered all that part of the lake, to the extent of at leaſt half an acre, as ſmooth as glaſs. The curious effect produced by this liquid may be accounted for by the repulſion which exiſts between oil and water, and between oil and air, which prevents all immediate contact, all rubbing of the one upon the other.

14 Calmed by oil.

15 Motion towards the weſt—Currents.

2. The ſecond kind of motion is that continual tendency which the whole water in the ſea has towards the weſt. It is greater near the equator than about the poles; and indeed cannot be ſaid to take place at all in the northern hemiſphere beyond the trophic. It begins on the weſt ſide of America, where it is moderate: hence that part of the ocean has been called *Pacific*. As the waters advance weſtward their motion is accelerated; ſo that, after having traverſed the globe, they ſtrike with great violence on the eaſtern ſhore of America. Being ſtopped by that continent, they turn northward, and run with conſiderable impetuoſity in the gulf of Mexico; from thence they proceed along the coaſt of North America, till they come to the ſouth ſide of the great bank at Newfoundland, when they turn off, and run down through the Weſtern Iſles. This current is called the *Gulf Stream*. It was firſt accurately deſcribed by Dr Franklin, who remarked alſo, that the water in it having been originally heated in the torrid zone, cools ſo gradually in its paſſage northward, that even the latitude might be found in any part of the ſtream by means of a thermometer.—This motion of the ſea weſtward has never been explained: it ſeems to have ſome connection with the trade-winds and the diurnal revolution of the earth on its axis.

16 Motion occaſioned by the tide.

3. The third and moſt remarkable motion of the ſea is the tide, which is a regular ſwell of the ocean once every 12 hours, owing, as Newton has demonſtrated, to the attraction of the moon. In the middle of the ſea the tide ſeldom riſes higher than one or two feet,

but on the coaſt it frequently reaches the height of 45 feet, and, in ſome places even more. The tide generally riſes higher in the evening than in the morning: on the coaſt of Britain this holds in winter, but in ſummer the morning tides are higheſt. In ſome ſeas it is ſaid that there are no tides. This cannot be owing to their being ſurrounded by land, becauſe there is a tide in the lakes of North America. For an explanation of theſe and other phenomena we refer to the article TIDE.

SEA-Air, that part of the atmoſphere which is above the ſea.

Sea-air has been found ſalubrious and remarkably beneficial in ſome diſtempers. This may be owing to its containing a greater portion of oxigenous gas or vital air, and being leſs impregnated with noxious vapours than the land. Dr Ingenhouſz made ſeveral experiments to aſcertain the ſalubrity of ſea-air. By mixing equal meaſures of common air and nitrous air, he found, that at Graveſend, they occupied about 104, or one meaſure and $\frac{4}{100}$ of a meaſure: whereas on ſea, about three miles from the mouth of the Thames, two meaſures of air (one of common and one of nitrous air) occupied from 0.91 to 0.94. He attempted a ſimilar experiment on the middle of the channel between the Engliſh coaſt and Oſtend; but the motion of the ſhip rendered it impracticable. He found that in rainy and windy weather the ſea-air contained a ſmaller quantity of vital air than when the weather was calm. On the ſea-ſhore at Oſtend it occupied from $94\frac{1}{2}$ to 97; at Bruges he found it at 105; and at Antwerp $109\frac{1}{2}$. Dr Ingenhouſz thus concludes his paper:

Phil. Tranſ. 1780, p. 354.

It appears, from theſe experiments, that the air at ſea and cloſe to it is in general purer and fitter for animal life than the air on the land, though it ſeems to be ſubject to the ſame inconſtancy in its degree of purity with that of the land; ſo that we may now with more confidence ſend our patients, labouring under conſumptives diſorders, to the ſea, or at leaſt to places ſituated cloſe to the ſea, which have no marſhes in their neighbourhood. It ſeems alſo probable, that the air will be found in general much purer far from the land than near the ſhore, the former being never ſubject to be mixed with land air.

Dr Damman, an eminent phyſician and profeſſor royal of midwifery at Ghent, told Dr Ingenhouſz, that when he was formerly a practitioner at Oſtend, during ſeven years, he found the people there remarkably healthy; that nothing was rarer there than to ſee a patient labouring under a conſumption or aſthma, a malignant, putrid, or ſpotted fever; that the diſeaſe to which they are the moſt ſubject, is a regular intermittent fever in autumn, when ſudden tranſitions from hot to cold weather happen.

People are in general very healthy at Gibraltar, though there are very few trees near that place; which Dr Ingenhouſz thinks is owing to the purity of the air ariſing from the neighbourhood of the ſea.

Moſt ſmall iſlands are very healthy.

At Malta people are little ſubject to diſeaſes, and live to a very advanced age.

SEA-Anemony. See *ANIMAL-Flower*.

SEA-Bear. } See PHOCA, } MAMMALIA *Index*.
SEA-Calf. }
SEA-Cow. See TRICHECUS, }

SEA-Crow, *Mire-Crow*, or *Pewit*. See LARUS, ORNITHOLOGY *Index*.

SEA, *Dead*. See ASPHALTITES.

SEA-Devil. See LOPHIUS, ICHTHYOLOGY *Index*.

SEA-Dragon, a monſter of a very ſingular nature. In the Gentleman's Magazine for the year 1749, we have the account of a ſea-dragon which was ſaid to be taken between Orford and Southwould, on the coaſt of Suffolk, and afterwards carried round the country as a curioſity by the fiſhermen who caught it.

"Its head and tail (ſays the writer) reſemble thoſe of an alligator; it has two large fins, which ſerve it both to ſwim and to fly; and though they were ſo dried that I could not extend them, yet they appear, by the folds, to be ſhaped like thoſe which painters have given to dragons and other winged monſters that ſerve as ſupporters to coats of arms. Its body is covered with impenetrable ſcales; its legs have two joints, and its feet are hoofed like thoſe of an aſs: it has five rows of very white and ſharp teeth in each jaw, and is in length about four feet, though it was longer when alive, it having ſhrunk as it became dry.

"It was caught in a net with mackerel; and being dragged on ſhore, was knocked down with a ſtretcher or boat-hook. The net being opened, it ſuddenly ſprung up, and flew above 50 yards: the man who firſt ſeized it had ſeveral of his fingers bitten off; and the wound mortifying, he died. It afterwards faſtened on the man's arm who ſhows it, and lacerated it ſo much, that the muſcles are ſhrunk, and the hand and fingers diſtorted; the wound is not yet healed, and is thought to be incurable. It is ſaid by ſome to have been deſcribed by naturaliſts under the name of the *Sea-dragon*." We muſt add to the account now given of the monſter called a *ſea-dragon*, that we think it extremely probable that the animal was nothing more than a diſtorted or overgrown individual of ſome of the well known ſpecies of fiſh.

SEA-Gage. See *Sea-GAGE*.

SEA-Hare. See LAPLYSIA, HELMINTHOLOGY *Index*.

SEA-Horſe, in *Ichthyology*, the Engliſh name of the *Hippocampus*. See SYNGNATHUS, ICHTHYOLOGY *Index*.

SEA-Lemon. See DORIS, HELMINTHOLOGY *Index*.

SEA-Lion. See PHOCA, MAMMALIA *Index*.

SEA-Mall, or *SEA-Mew*. See LARUS, ORNITHOLOGY *Index*.

SEA-Man. See MERMAID.

SEA-Marks. The erection of beacons, light-houſes, and ſea-marks, is a branch of the royal PREROGATIVE. By 8 Eliz. 13. the corporation of the Trinity-houſe are empowered to ſet up any beacons or ſea-marks wherever they ſhall think them neceſſary; and if the owner of the land or any other perſon ſhall deſtroy them, or take down any ſteeple, tree, or other known ſea-mark, he ſhall forfeit 100l. ſterling; or, in caſe of inability to pay it, he ſhall be *ipſo facto* outlawed.

SEA-Needle, *Gar-fiſh*. See ESOX, ICHTHYOLOGY *Index*.

SEA-Nettle. See *ANIMAL-Flower*.

SEA-Pie, or *Oyſter-Catcher*. See HÆMATOPUS, ORNITHOLOGY *Index*.

SEA-Plants, are thoſe vegetables that grow in ſalt-water within the ſhores of the ſea. The old botaniſts divided

Sea. divided thefe into three claffes. 1. The firft clafs, according to their arrangement, contained the *algæ*, the *fuci*, the *fea-moffes* or *confervas*, and the different fpecies of fponges. 2. The fecond contained fubftances of a hard texture, like ftone or horn, which feem to have been of the fame nature with what we call *zoophyta*, with this difference, that we refer fponges to this clafs and not to the firft. The third clafs was the fame with our *lithophyta*, comprehending *corals*, *mandrepora*, &c. It is now well known that the genera belonging to the fecond and third of thefe claffes, and even fome referred to the firft, are not vegetables, but animals, or the productions of animals. See CORALLINA, MADREPORA, SPONGIA. Sea-plants, then, properly fpeaking, belong to the clafs of cryptogamia, and the order of algæ; and, according to Bomare, are all comprehended under the genus of fucus. We may alfo add feveral fpecies of the ulva and conferva and the fargazo. The fuci and marine ulvæ are immerfed in the fea, are feffile, and without root. The marine confervæ are either feffile or floating. The fargazo grows beyond foundings.

As fome fpecies of the fucus, when dried and preferved, are extremely beautiful, the curious, and efpecially thofe who profecute the ftudy of botany, muft be anxious to know the beft method of preferving them, without deftroying their colour and beauty. The following method is recommended by M. Mauduyt. Take a fheet of paper, or rather of pafteboard, and cover it with varnifh on both fides; and having rowed in a boat to the rock where the fucus abounds, plunge your varnifhed paper into the water, and, detaching the fucus, receive it upon the paper. Agitate the paper gently in the water, that the plant may be properly fpread over it; and lift them up together foftly out of the water: then fix down with pins the ftrong ftalks, that they may not be difplaced, and leave the plant lying upon the varnifhed paper to dry in the open air. When it is fully dry, the different parts will retain their pofition, and the plant may be preferved within the leaves of a book. To free it from the flime and falt which adhere to it, wafh it gently in frefh water, after being removed from the rock on which it grew.

SEA-Serpent, a monftrous creature, faid to inhabit the northern feas about Greenland and the coafts of Norway. The following marvellous account of this monfter is given by Guthrie. "In 1756, one of them was fhot by a mafter of a fhip: its head refembled that of a horfe; the mouth was large and black, as were the eyes, a white mane hanging from its neck: it floated on the furface of the water, and held its head at leaft two feet out of the fea: between the head and neck were feven or eight folds, which were very thick; and the length of this fnake was more than 100 yards, fome fay fathoms. They have a remarkable averfion to the fmell of caftor; for which reafon, fhip, boat, and bark mafters provide themfelves with quantities of that drug, to prevent being overfet, the ferpent's olfactory nerves being remarkably exquifite. The particularities related of this animal would be incredible, were they not attefted upon oath. Egede, a very reputable author, fays, that on the 6th day of July 1734, a large and frightful fea-monfter raifed itfelf fo high out of the water, that its head reached above the main-top-maft of the fhip; that it had a long fharp fnout, broad paws, and fpouted water like a whale; that the body feemed to be covered with fcales; the fkin was uneven and wrinkled, and the lower part was formed like a fnake. The body of this monfter is faid to be as thick as a hogfhead; his fkin is variegated like a tortoife fhell; and his excrement, which floats upon the furface of the water, is corrofive." Notwithftanding the belief of Guthrie, and the teftimony which he produces, we cannot help doubting of the exiftence of the fea-ferpent. Its bulk is faid to be fo difproportionate to all the known animals of our globe, that it requires more than ordinary evidence to render it credible; but the evidence which is offered is fo very feeble and unfatisfactory, that no man of found judgement would think it fufficient to eftablifh the truth of an extraordinary fact. Sea.

Attempts have lately been made to revive the opinion of the exiftence of fea-mermaids and fea-ferpents. An individual of the latter, it is fuppofed, was fome time ago thrown on fhore in Orkney. Part of the fkeleton is faid to be in the mufeum of the Univerfity of Edinburgh, and another part is in the poffeffion of Mr Home of London, who thinks that it may have belonged to an individual of fome of the whale tribe, perhaps a monfter of that tribe; but according to others it is to be confidered as conftituting a diftinct genus. We cannot avoid obferving, that this point muft remain unfettled till other fpecies of this new genus have been difcovered, or at leaft till an entire individual have been defcribed by an experienced naturalift.

SEA-Sicknefs, a diforder incident to moft perfons on their firft going to fea, occafioned by the agitation of the veffel. This diforder has not been much treated of, although it is very irkfome and diftreffing to the patient during its continuance. It has, however, been found beneficial in afthmatic and pulmonary complaints, and the inftances in which it has proved fatal, are extremely rare. The fea-ficknefs appears to be a fpafmodic affection of the ftomach, occafioned by the alternate preffure and recefs of its contents againft its lower internal furface, according as the rife and fall of the fhip oppofe the action of gravity.

The feas in which the attacks of this diforder are accompanied with the greateft violence, are thofe where the waves have an uninterrupted freedom of action; and of confequence bays, gulfs and channels, may be navigated with lefs inconvenience, as the waves, meeting with more frequent refiftance, the veffel does not experience that gentle uniform vacillation which induces ficknefs, and renders the head giddy. A perfon feels lefs inconvenience from the diforder in a fmall veffel on the wide ocean, on which the flighteft motion of the waves makes a ftrong impreffion. He is alfo lefs expofed to it in a very large veffel deeply laden, as the waves, in this cafe, fcarcely affect the veffel. It is in fhips of an ordinary fize, and which carry but a light cargo, that the paffenger fuffers moft from the fea-ficknefs. The fooner it takes place after embarkation, the continuance of it becomes the more probable. It does not always ceafe immediately on landing, but in fome cafes continues for a confiderable time.

Many methods of preventing, or at leaft of mitigating this diforder, have been recommended, of which the moft efficacious appear to be the following.

1. Not to go on board immediately after eating, and not to eat, when on board, any large quantity at a time.

2. To

2. To take much exercise, with as little intermission as possible; as indolent passengers are always the greatest sufferers from the disorder.

3. To keep much upon deck, even when the weather is stormy, as the sea breeze is not so apt to affect the stomach as the impure air of the cabin, rendered so for want of proper circulation.

4. Not to watch the motion of the waves, particularly when strongly agitated with tempest.

5. Carefully to shun all employments by which the mind may be harassed, as reading, studying, gaming, &c. and to seek all opportunities of mental relaxation.

6. To drink occasionally liquids containing carbonic acid, as the froth of beer strongly fermented, or wine and Seltzer water mixed together, and sweetened with pounded sugar.

7. It will also be beneficial to take sulphuric acid dulcified, dropped on a bit of sugar, or in peppermint water, or ten drops of ether.

The proper diet consists of bread and fresh meat, to be eaten cold with pepper. All sweet savoured food should be carefully avoided, and the passenger ought to refrain from fat, and particularly from such meat as is in the smallest degree tainted. Even the smell of flowers is injurious, for which reason marine productions ought not to be examined; but the fumes of vinegar may be advantageously inhaled. The drink should consist of lemonade or tart wines, but never of common water. An accidental diarrhœa has often relieved the patient from sea-sickness, and therefore a gentle laxative in such a disorder seems to be indicated. It will also be found useful to apply a tonic anodyne plaster to the pit of the stomach, spread upon leather, and covered with linen.

When symptoms of vomiting appear, they may often be remedied by the patient placing himself in a horizontal position on his back or belly, and lying perfectly still. If the fits of vomiting are too violent to be repressed, they should be promoted by a strong dose of salt water; not, however, to be often repeated, as it debilitates the stomach. When the emetic operates, the patient should bend his body, bringing his knees towards his breast, and supporting his head against a firm resting-place. His garters and cravat must be untied, a precaution which will secure him from the danger of a rupture.

The vomiting having subsided, a state of repose will prevent its return, and the eyes may be kept shut for a considerable time. The patient must make choice of a cool, ventilated place, remembering to keep himself warm and well clothed, as perspiration is highly beneficial. A gargle of sugar dissolved in vinegar is to be taken in the morning, accompanied with frequent and spare eating. Water must never be taken in its pure state, but mixed with wine, vinegar, or brandy. A glass of wine may be taken in the morning, with an infusion of orange peel, gentian root, or peruvian bark. A glass of punch occasionally taken will be extremely beneficial, by which perspiration is promoted.

Persons accustomed to smoke tobacco, will find the use of the pipe salutary on such occasions, but the practice of smoking will be injurious to all others. We may add that warm clothing, flannel shirts, caps, trowsers, &c. are powerful remedies against excessive expectoration, with every other symptom of this dreadful malady.

SEA-Star. See ASTERIAS, } HELMINTHOLOGY *Index*.
SEA-Urchin. See ECHINUS, }

SEA-Water, the salt water of the sea. The principal salts contained in sea-water are, 1st, Common marine or culinary salt, compounded of fossil alkali or soda and marine acid; 2dly, A salt formed by the union of the same acid with magnesian earth; and, lastly, A small quantity of selenite. The quantity of saline matter contained in a pint of sea-water, in the British seas, is, according to Neumann, about one ounce in each pint (A).

The saltness of this water is supposed to arise from numerous mines and mountains of salt dispersed here and there in the depths of the sea. Dr Halley supposes that it is probable the greatest part of the sea-salt, and of all salt lakes, as the Caspian sea, the Dead sea, the lake of Mexico, and the Titicaca in Peru, is derived from the water of the rivers which they receive: and since this sort of lakes has no exit or discharge but by the exhalation of vapours, and also since these vapours are entirely fresh or devoid of such particles, it is certain that the saltness of the sea and of such lakes must from time to time increase; and therefore the saltness at this time must be greater than at any time heretofore. He further adds, that if, by experiments made in different ages, we could find the different quantity of salt which the same quantity of water (taken up in the same place, and in all other the same circumstances) would afford, it would be easy from thence, by rules of proportion, to find the age of the world very nearly, or the time wherein it has been acquiring its present saltness.

This opinion of Dr Halley is so improbable, that it is surprising so acute a philosopher could have adopted it. That fresh water rivers should in the course of many thousand years produce saltness in the sea, is quite incredible. If this were the case, every sea or great body of water which receives rivers must be salt, and must possess a degree of saltness in proportion to the quantity of water which the rivers discharge. But so

(A) In Bergman's analysis of sea-water taken up in the beginning of June 1776, about the latitude of the Canaries, from the depth of 60 fathoms, the solid contents of a pint of the water were,

	Grs.				
Of common salt	$253\frac{6}{11}$		ʒ.	℈	Grs.
Salited magnesia	$69\frac{1}{11}$	or	5	1	$10\frac{9}{11}$
Gypsum	$8\frac{2}{11}$				
Total	$330\frac{9}{11}$				

fo far is this from being true, that the Palus Meotis and the great lakes in America do not contain falt but frefh water. It may indeed be objected, that the quantity of falt which the rivers carry along with them and depofit in the fea, muft depend on the nature of the foil through which they flow, which may in fome places contain no falt at all: and this may be the reafon why the great lakes in America and the Palus Meotis are frefh. But to this opinion, which is merely hypothetical, there are unfurmountable objections. It is a curious fact that the faltnefs of the fea is greateft under the line, and diminifhes gradually as we advance to the poles: We muft therefore fuppofe, if Dr Halley's theory be true, that the earth contains more falt in the tropical regions than in the temperate zones, and more in the temperate zones than in the frigid; and confequently that the rivers in thefe different regions contain a quantity of falt proportionable to their diftance from the equator. This, however, muft be firft proved by experiment, and cannot be affumed as an eftablifhed fact. But there is another circumftance that entirely deftroys this theory. If we allow that the fea receives its faltnefs from the rivers, it muft be equally falt or nearly fo in every part of the earth. For, according to a fimple and well known principle in chemiftry, "when any fubftance is diffolved in water with the affiftance of agitation, at whatever part of the water it is introduced, it will be equally diffufed through the whole liquid." Now though it were true that a greater quantity of falt were introduced into the fea under the line than towards the poles, from the conftant agitation occafioned by the wind and tide, the falt muft foon pervade the whole mafs of water. To fay that the fuperior degree of heat in the tropical regions may diffolve a greater quantity of falt, will not deftroy our argument; for it is an eftablifhed principle in chemiftry, that cold water will diffolve nearly as great a quantity of falt as hot water can diffolve.

The faltnefs of the fea has alfo been afcribed to the folution of fubterraneous mines of falt which is fuppofed to abound in the bottom of the fea and along its fhores. But this hypothefis cannot be fupported. If the fea were conftantly diffolving falt, it would foon become faturated; for it cannot be faid that it is deprived of any part of its falt by evaporation, fince rain-water is frefh. If the fea were to become faturated, neither fifhes nor vegetables could live in it. We muft therefore defpair of being able to account for the faltnefs of the fea by fecond caufes; and muft fuppofe that it has been falt from the creation. It is impoffible indeed to fuppofe that the waters of the fea were at any period frefh fince the formation of fifhes and fea-plants: for as thefe will not live in water faturated with falt, neither will they live in water that is frefh; we therefore conclude that the faltnefs of the fea has been nearly the fame in all ages. This is the fimpleft hypothefis of the three that has been mentioned. It explains beft the various phenomena, and is involved in feweft difficulties. We fhall, however, allow that there may be fome exceptions; that the faltnefs of fome feas, or of particular parts of the fame fea, may be increafed by mines of rock-falt difperfed near its fhores.

With regard to the ufe of this falt property of fea-water, it is obferved, that the faltnefs of the fea preferves its waters pure and fweet, which otherwife would corrupt and ftink like a filthy lake, and confequently that none of the myriads of creatures which now live therein could then have a being. From thence alfo the fea water becomes much heavier, and therefore fhips of greater fize and quantity may be ufed thereon. Salt-water alfo doth not freeze fo foon as frefh-water, whence the feas are more free for navigation. We have a differtation, by Dr Ruffel, concerning the medical ufes of fea-water in difeafes of the glands, &c. wherein the author premifes fome obfervations upon the the nature of fea-water, confidered as impregnated with particles of all the bodies it paffes over, fuch as fubmarine plants, fifh, falts, minerals, &c. and faturated with their feveral effluvia, to enrich it and keep it from putrefaction: whence this fluid is fuppofed to contract a foapinefs; and the whole collection, being pervaded by the fulphureous fteams paffing through it, to conftitute what we call *fea-water;* the confeffed diftinguifhing characteriftics of which are faltnefs, bitternefs, nitrofity, and unctuofity: whence the author concludes, that it may be juftly expected to contribute fignally to the improvement of phyfic. The cafes in which our author informs us we are to expect advantages from fea-water are, 1. In all recent obftructions of the glands of the inteftines and mefentery. 2. All recent obftructions of the pulmonary glands, and thofe of the vifcera, which frequently produce confumptions. 3. All recent glandular fwellings of the neck, or other parts. 4. Recent tumors of the joints, if they are not fuppurated, or become fchirrous or cancerous, and have not carious bones for their caufe. 5. Recent defluxions upon the glands of the eyelids. 6. All defœdations of the fkin, from an eryfipelas to a lepra. 7. Difeafes of the glands of the nofe, with their ufual companion a thicknefs of the lip. 8. Obftructions of the kidneys, where there is no inflammation, and the ftone not large. 9. In recent obftructions of the liver, this method will be proper, where it prevents conftipations of the belly, and affifts other medicines directed in icterical cafes. The fame remedy is faid to be of fignal fervice in the bronchocele; and is likewife recommended for the prevention of thofe bilious colics that fo frequently affect our mariners.

Prefervation of SEA-Water from Putrefaction. As it is fometimes neceffary to preferve fea-water in cafks for bathing and other purpofes, it is of importance to know how to keep it from putrefaction. Many experiments were made to determine this point by Mr Henry, and are recorded in the firft volume of the Memoirs of the Literary and Philofophical Society of Manchefter. His firft experiment we fhall here prefent to our readers. "To one quart of fea-water were added two fcruples of frefh quick-lime; to another, half an ounce of common culinary falt; and a third was kept as a ftandard without any addition. The mouths of the bottles being loofely covered with paper, they were expofed to the action of the fun in fome of the hotteft weather in fummer. In about a week the ftandard became very offenfive; and the water, with the additional quantity of falt, did not continue fweet many hours longer; whereas that with lime continued many months without ever exhibiting the leaft marks of putridity." When he added a dram more of quicklime, the whole of the magnefia contained in the water was feparated; and when a further addition was made, a lime-water was

Sea. immediately formed. He therefore concluded, that two fcruples of quicklime are fufficient to preferve a quart of fea-water. The proportions, however, may vary a little, according to the ftrength of the quicklime employed.

1 Different methods of frefhening fea-water.

Frefhening of SEA-Water. The method of making fea-water frefh was long a defideratum in navigation. Many methods have been propofed for this purpofe. Mr Appleby publifhed an account of a procefs which he had inftituted in the year 1734. He diftilled fea-water with a quantity of *lapis infernalis* and calcined bones; but this procefs was foon laid afide, as it was not only difficult in itfelf, but rendered the water unpalatable. Dr Butler propofed foap-leys in place of Mr Appleby's ingredients; but the water was ftill liable to the fame objection. Dr Stephen Hales recommended powdered chalk; but his method was expenfive, and did not improve the tafte of the water. Dr Lind of Portfmouth diftilled fea-water without any ingredients; but as the experiment he made was performed in a veffel containing only two quarts, with a glafs receiver, in his ftudy, nothing conclufive can be drawn from it for the ufe of failors.

2 Dr Irving's

At length Dr Irving brought the procefs to a very high degree of fimplicity and perfection, by which the water is obtained pure, without much expence of fuel or a complicated apparatus. For this valuable difcovery he received a reward of 5000l. The advantages of this method remain to be ftated, which may be reduced to the following: 1. The abolifhing all ftills, ftillheads, worm-pipes, and their tubes, which occupy fo much fpace as to render them totally incompatible with the neceffary bufinefs of the fhip; and ufing in the room of thefe the fhip's kettle or boiler, to the top whereof may occafionally be applied a fimple tube, which can be eafily made on board a veffel at fea, of iron plate, ftove funnel, or tin fheet; fo that no fituation can prevent a fhip from being completely fupplied with the means of diftilling fea-water. 2. In confequence of the principles of diftillation being fully afcertained, the contrivance of the fimpleft means of obtaining the greateft quantity of diftilled water, by making the tube fufficiently large to receive the whole column of vapour, and placing it nearly in a horizontal direction, to prevent any compreffion of the fluid, which takes place fo much with the common worm. 3. The adopting of the fimpleft and moft efficacious means of condenfing vapour; for nothing more is required in the diftillation but keeping the furface of the tube always wet, which is done by having fome fea-water at hand, and a perfon to dip a mop or fwab into this water, and pafs it along the upper furface of the tube. By this operation the vapour contained in the tube will be entirely condenfed with the greateft rapidity imaginable; for by the application of the wet mop thin fheets of water are uniformly fpread, and mechanically preffed upon the furface of the hot tube; which being converted into vapour make way for a fucceffion of frefh fheets; and thus, both by the evaporation and clofe contact of the cold water conftantly repeated, the heat is carried off more effectually than by any other method yet known. 4. The carrying on the diftillation without any addition, a correct chemical analyfis of fea-water having evinced the futility of mixing ingredients with it, either to prevent an acid from rifing with the vapour, or to deftroy any bituminous oil fuppofed to exift in fea-water, and to contaminate the diftilled water, giving it that fiery unpalatable tafte infeparable from the former proceffes. 5. The afcertaining the proper quantity of fea-water that ought to be diftilled, whereby the frefh water is prevented from contracting a noxious impregnation of metallic falts, and the veffel from being corroded and otherwife damaged by the falts caking on the bottom of it. 6. The producing a quantity of fweet and wholefome water, perfectly agreeable to the tafte, and fufficient for all the purpofes of fhipping. 7. The taking advantage of the dreffing the fhip's provifions, fo as to diftil a very confiderable quantity of water from the vapour, which would otherwife be loft, without any addition of fuel. To fum up the merits of this method in a few words: The ufe of a fimple tube, of the moft eafy conftruction, applicable to any fhip's kettle. The rejecting all ingredients; afcertaining the proportion of water to be diftilled, with every advantage of quality, faving of fuel, and prefervation of boilers. The obtaining frefh water, wholefome, palatable, and in fufficient quantities. Taking advantage of the vapour which afcends in the kettle while the fhip's provifions are boiling. All thefe advantages are obtained by the above mentioned fimple addition to the common fhip's kettles. But Dr Irving propofes to introduce two further improvements. The firft is a hearth, or ftove, fo conftructed that the fire which is kept up the whole day for the common bufinefs of the fhip ferves likewife for diftillation; whereby a fufficient quantity of water for all the economical purpofes of the fhip may be obtained, with a very inconfiderable addition to the expence of fuel. The other improvement is that of fubftituting, even in the largeft fhips, caft-iron boilers, of a new conftruction, in the place of coppers.

3 Directions for diftilling fea-water.

As foon as fea-water is put into the boiler, the tube is to be fitted either into the top or lid, round which, if neceffary, a bit of wet linen may be applied, to make it fit clofe to the mouth of the veffel; there will be no occafion for luting, as the tube acts like a funnel in carrying off the vapour. When the water begins to boil, the vapour fhould be allowed to pafs freely for a minute, which will effectually clean the tube and upper part of the boiler. The tube is afterwards to be kept conftantly wet, by paffing a mop or fwab, dipped in fea water, along its upper furface. The wafte water running from the mop may be carried off by means of a board made like a fpout, and placed beneath the tube. The diftillation may be continued till three-fourths of the water be drawn off, and no further. This may be afcertained either by a gauge-rod put into the boiler, or by meafuring the water diftilled. The brine is then to be let out. Water may be diftilled in the fame manner while the provifions are boiling. When the tube is made on fhore, the beft fubftance for the purpofe is thin copper well tinned, this being more durable in long voyages than tin-plates. Inftead of mopping, the tube, if required, may have a cafe made alfo of copper, fo much larger in diameter as to admit a thin fheet of water to circulate between them by means of a fpiral copper thread, with a pipe of an inch diameter at each end of the cafe; the lower for receiving cold water, and the upper for carrying it off when heated.

When only a very fmall portion of room can be conveniently allowed for diftillation, the machine (fig. 2.), which is only 27 inches long, may be fubftituted, as

was

Fig. 1.

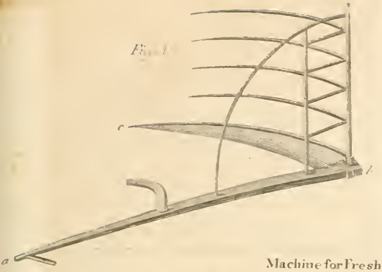


Fig. 2.

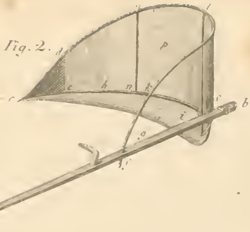


Fig. 3.

Machine for Freshening SEA WATER.

Fig. 1.

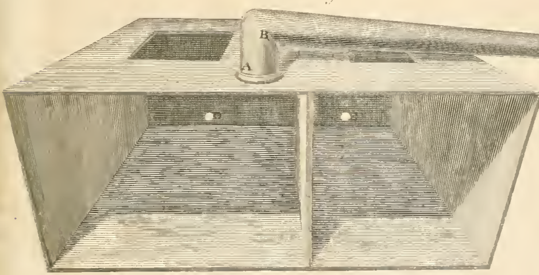
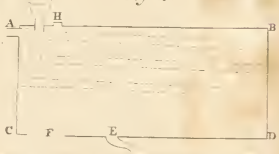


Fig. 2.



SECTOR.

Fig. 3.

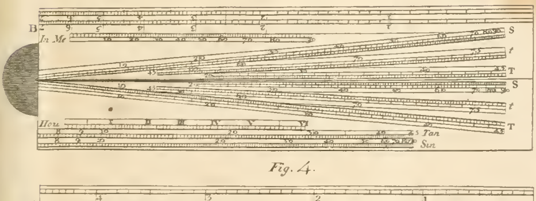


Fig. 1.

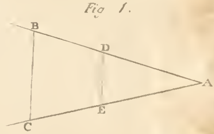
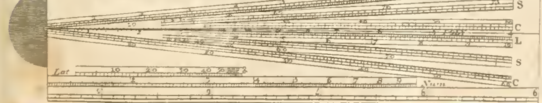
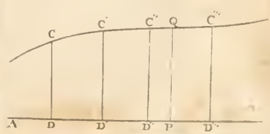


Fig. 4.



SERIES.



Sea. was done in this voyage. The principal intention of this machine, however, is to distil rum and other liquors; for which purpofe it has been employed with extraordinary fuccefs, in preventing an *empyreuma*, or fiery tafte.

Plate cccclxxviii. Fig. 1. Figure 1. reprefents in perfpective a fection of the two boilers taken out of the frame. In the back part at D, E, are feen openings for the cocks. On the top is a diftilling tube A, B, C, five inches diameter at A, and decreafing in fize to three inches at C; the length from B to C is five feet. Near C is a ring to prevent the water which is applied to the furface from mixing with the diftilled water. In the infide of the tube, below B, is a fmall lip or ledging, to hinder the diftilled water from returning into the boiler by the rolling of the fhip.

Fig. 2. In figure 2. A, B, C, D, reprefent a vertical fection of a copper box, 27 inches long, feven inches wide, and 11 in height, tinned on the infide. In the bottom F is an aperture about fix inches in diameter, having a ring to fit on the ftill or boiler. The dotted lines which run nearly horizontal, are veffels of thin copper, tinned on the outfide, two feet long, feven inches wide, and three quarters of an inch deep. At G is a funnel to receive cold water, which is conveyed into the veffels by communicating pipes, contrived in fuch a manner as to form a complete and quick circulation of the water through their whole extent. When the water is become hot by the action of the fteam, it is difcharged by the horizontal pipe at A. E is a pipe from which the diftilled water or fpirits run, and is bent in fuch a form that the liquor running from it acts as a valve, and hinders any fteam from efcaping that way. On the top of the box, at H, is a fafety-valve, which prevents any danger from a great accumulation of vapour not condenfed for want of a proper fupply of cold water.

4 Lorgna's method of frefhening it by congelation. We fhall now mention a different method, difcovered by the Chevalier Lorgna, by congelation of fea-water. Sea-water requires a very great degree of cold in order to become ice. Our author found that a freezing mixture, made by mixing three parts of pounded ice with two parts of common falt, was quite fufficient to freeze it. The cold produced by this mixture is equal to about 4° below 0 of Fahrenheit's thermometer.

A quantity of fea-water is never entirely congealed, a portion of it always remaining fluid; and, what is very remarkable, this fluid part is incomparably more full of falt and more naufeous than the reft: hence, if this be feparated from the congealed part, the latter on being melted will be found to contain much lefs falt than it did before congelation. This we fhall call *the water of the firft purification.*

If the water of the firft purification be again congealed, a part of it will remain fluid as in the firft operation. This fluid portion will contain a greater proportion of falt than the reft, which is of courfe more pure, and, being melted, forms the water of the fecond purification. Thus, by repeatedly freezing the fame fea water, and feparating the fluid from the congealed part in every operation, it is at laft perfectly purified, fo as to be entirely divefted of falt, and as fit for drink and other purpofes as the pureft water that is ufed.

At firft the fea-water, in order to be congealed, requires a very great degree of cold, as mentioned above, the ice formed in it confifts rather of fcales or filaments than of a compact body, and the quantity of the fluid parts bears a confiderable proportion to the quantity of ice. But as the water, by undergoing the fucceffive congelations, becomes more and more pure, fo it becomes capable of being congealed by a fmaller and fmaller degree of cold; the ice is at the fame time more compact, and in greater quantity; the fluid part at laft becoming very inconfiderable. Sea.

SEA-Weed, or *Alga Marina*, is commonly ufed as a manure on the fea-coaft, where it can be procured in abundance. The beft fort grows on rocks, and is that from which kelp is made. The next to this is called the *peafy fea-weed;* and the worft is that with a long ftalk. In the neighbourhood of Berwick, the farmers mix it with ftable dung and earth, and thus obtain a great quantity of excellent manure. Sea-weed is found alfo to be a very fit manure for gardens, as it not only enriches them, but deftroys the vermin by which they are ufually infefted.

SEA-Wolf. See ANARRHICAS, ICHTHYOLOGY *Index.*

Saltnefs of the SEA. See *SEA-Water.*

South SEA. See *PACIFIC Ocean*, and *SOUTH Sea.*

SEAL, a puncheon, piece of metal, or other matter, ufually either round or oval; whereon are engraven the arms, device, &c. of fome prince, ftate, community, magiftrate, or private perfon, often with a legend or infcription; the impreffion whereof in wax ferves to make acts, inftruments, &c. authentic.

The ufe of feals, as a mark of authenticity to letters and other inftruments in writing, is extremely ancient. We read of it among the Jews and Perfians in the earlieft and moft facred records of hiftory. And in the book of Jeremiah there is a very remarkable inftance, not only of an atteftation by feal, but alfo of the other ufual formalities attending a Jewifh purchafe. In the civil law alfo, feals were the evidence of truth, and were required, on the part of the witneffes at leaft, at the atteftation of every teftament. But in the times of our Saxon anceftors, they were not much in ufe in England. For though Sir Edward Coke relies on an inftance of King Edwyn's making ufe of a feal about 100 years before the Conqueft, yet it does not follow that this was the ufage among the whole nation: and perhaps the charter he mentions may be of doubtful authority, from this very circumftance of its being fealed; fince we are affured by all our ancient hiftorians that fealing was not then in common ufe. The method of the Saxons was, for fuch as could write to fubfcribe their names, and, whether they could write or not, to affix the fign of the crofs; which cuftom our illiterate vulgar do for the moft part to this day keep up, by figning a crofs for their mark when unable to write their names. And indeed this inability to write, and therefore making a crofs in its ftead, is honeftly avowed by Caedwalla, a Saxon king, at the end of one of his charters. In like manner, and for the fame infurmountable reafon, the Normans, a brave but illiterate nation, at their firft fettlement in France ufed the practice of fealing only, without writing their names; which cuftom continued when learning made its way among them, though the reafon for doing it had ceafed; and hence the charter of Edward the Confeffor to Weftminfter-abbey, himfelf being brought up in Normandy, was witneffed only by his feal, and is generally thought to be the oldeft fealed charter of any authenticity in England.

land. At the Conqueſt, the Norman lords brought over into this kingdom their own faſhions; and introduced waxen ſeals only, inſtead of the Engliſh method of writing their names, and ſigning with the ſign of the croſs. The impreſſions of theſe ſeals were ſometimes a knight on horſeback, ſometimes other devices; but coats of arms were not introduced into ſeals, nor indeed uſed at all till about the reign of Richard I. who brought them from the croiſade in the Holy Land, where they were firſt invented and painted on the ſhields of the knights, to diſtinguiſh the variety of perſons of every Chriſtian nation who reſorted thither, and who could not, when clad in complete ſteel, be otherwiſe known or aſcertained.

This neglect of ſigning, and reſting only upon the authenticity of ſeals, remained very long among us; for it was held in all our books, that ſealing alone was ſufficient to authenticate a deed: and ſo the common form of atteſting deeds, "ſealed and delivered," continues to this day; notwithſtanding the ſtatute 29 Car. II. c. 3. revives the Saxon cuſtom, and expreſsly directs the ſigning in all grants of lands and many other ſpecies of deeds: in which, therefore, ſigning ſeems to be now as neceſſary as ſealing, though it hath been ſometimes held that the one includes the other.

The king's *great ſeal* is that whereby all patents, commiſſions, warrants, &c. coming down from the king are ſealed; the keeping whereof is in the hands of the lord chancellor. The king's *privy ſeal* is a ſeal that is uſually firſt ſet to grants that are to paſs the great ſeal.

SEAL. See *KEEPER of the Privy Seal.*

SEAL is alſo uſed for the wax or lead, and the impreſſion thereon affixed to the thing ſealed.

An amalgam of mercury with gold, reduced to the conſiſtence of butter, by ſtraining off part of the mercury through leather, has been recommended as a proper material for taking off the impreſſion of ſeals in wax. In this ſtate, the compound ſcarcely contains one part of mercury to two of gold; yet is of a ſilver whiteneſs, as if there was none of the precious metal in it. In this ſtate it grows ſoft on being warmed or worked between the fingers; and is therefore proper for the purpoſe above-mentioned, but is not ſuperior to ſome amalgams made with the inferior metals, as is well known to ſome impoſtors, who have ſold for this uſe amalgams of the baſe metals as curious preparations of gold.

SEAL. See PHOCA, MAMMALIA *Index*.

SEALER, an officer in chancery appointed by the lord chancellor or keeper of the great ſeal, to ſeal the writs and inſtruments there made in his preſence.

SEALING, in *Architecture*, the fixing a piece of wood or iron in a wall with plaſter, mortar, cement, lead, or other ſolid binding. For ſtaples, hinges, and joints, plaſter is very proper.

SEALING-Wax. See WAX.

SEAM, or SEME, of corn, is a meaſure of eight buſhels.

SEAM of Glaſs, the quantity of 120 pounds, or 24 ſtones, each five pounds weight. The ſeam of wood is an horſe-load working.

SEAM, in mines, the ſame with a ſtratum or bed; as a ſeam of coal.

SEAMANSHIP.

1 Definition.

BY this word we expreſs that noble art, or, more purely, the qualifications which enable a man to exerciſe the noble art of working a ſhip. A SEAMAN, in the language of the profeſſion, is not merely a mariner or labourer on board a ſhip, but a man who underſtands the ſtructure of this wonderful machine, and every ſubordinate part of its mechaniſm, ſo as to enable him to employ it to the beſt advantage for puſhing her forward in a particular direction, and for avoiding the numberleſs dangers to which ſhe is expoſed by the violence of the winds and waves. He alſo knows what courſes can be held by the ſhip, according to the wind that blows, and what cannot, and which of theſe is moſt conducive to her progreſs in her intended voyage; and he muſt be able to perform every part of the neceſſary operation with his own hands. As the ſeamen expreſs it, he muſt be able "to hand, reef, and ſteer."

2 Importance and

We are juſtified in calling it a *noble art*, not only by its importance, which it is quite needleſs to amplify or embelliſh, but by its immenſe extent and difficulty, and the prodigious number and variety of principles on which it is founded—all of which muſt be poſſeſſed in ſuch a manner that they ſhall offer themſelves without reflection in an inſtant, otherwiſe the pretended ſeaman is but a lubber, and cannot be truſted on his watch.

The art is practiſed by perſons without what we call *education*, and in the humbler walks of life, and therefore it ſuffers in the eſtimation of the careleſs ſpectator. It is thought little of, becauſe little attention is paid to it. But if multiplicity, variety, and intricacy of principles, and a ſyſtematic knowledge of theſe principles, intitle any art to the appellation of *ſcientific* and *liberal*, ſeamanſhip claims theſe epithets in an eminent degree. We are amuſed with the pedantry of the ſeaman, which appears in his whole language. Indeed it is the only pedantry that amuſes. A ſcholar, a ſoldier, a lawyer, nay, even the elegant courtier, would diſguſt us, were he to make the thouſandth part of the alluſions to his profeſſion that is well received from the jolly ſeaman; and we do the ſeaman no more than juſtice. His profeſſion *muſt* engroſs his whole mind, otherwiſe he can never learn it. He poſſeſſes a prodigious deal of knowledge; but the honeſt tar cannot tell what he knows, or rather what he feels, for his ſcience is really at his fingers ends. We can ſay with confidence, that if a perſon of education, verſed in mechanics, and acquainted with the ſtructure of a ſhip, were to obſerve with attention the movements which are made on board a firſt or ſecond rate ſhip of war during a ſhifting ſtorm, under the direction of an intelligent officer, he would be rapt in admiration.

3 Difficulty of the art,

What a pity it is that an art ſo important, ſo difficult, and ſo intimately connected with the invariable laws of mechanical nature, ſhould be ſo held by its poſſeſſors, that it cannot improve, but muſt die with each individual. Having no advantages of previous education,

tion, they cannot arrange their thoughts; they can hardly be ſaid to think. They can far leſs expreſs or communicate to others the intuitive knowledge which they poſſeſs; and their art, acquired by habit alone, is little different from an inſtinct. We are as little intitled to expect improvement here as in the architecture of the bee or the beaver. The ſpecies (pardon the alluſion, ye generous hearts of oak) cannot improve. Yet a ſhip is a machine. We know the forces which act on it, and we know the reſults of its conſtruction—all theſe are as fixed as the laws of motion. What hinders this to be reduced to a ſet of practical maxims, as well founded and as logically deduced as the working of a ſteam engine or a cotton mill. The ſtoker or the ſpinner acts only with his hands, and may "whiſtle as he works, for want of thought;" but the mechaniſt, the engineer, thinks for him, improves his machine, and directs him to a better practice. May not the rough ſeaman look for the ſame aſſiſtance; and may not the ingenious ſpeculatiſt in his cloſet unravel the intricate thread of mechaniſm which connects all the manual operations with the unchangeable laws of nature, and both furniſh the ſeaman with a better machine and direct him to a more dexterous uſe of it?

4 which has been zealouſly cultivated by the French philoſophers.

We cannot help thinking that much may be done; nay, we may ſay that much has been done. We think highly of the progreſſive labours of Renaud, Pitot, Bouguer, Du Hamel, Groignard, Bernoulli, Euler, Romme, and others; and are both ſurpriſed and ſorry that Britain has contributed ſo little in theſe attempts. Gordon is the only one of our countrymen who has given a profeſſedly ſcientific treatiſe on a ſmall branch of the ſubject. The government of France has always been ſtrongly impreſſed with the notion of great improvements being attainable by ſyſtematic ſtudy of this art; and we are indebted to the endeavours of that ingenious nation for any thing of practical importance that has been obtained. M. Bouguer was profeſſor of hydrology at one of the marine academies of France, and was enjoined, as part of his duty, to compoſe diſſertations both on the conſtruction and the working of ſhips. His *Traité du Navire*, and his *Manœuvre des Vaiſſeaux*, are undoubtedly very valuable performances: So are thoſe of Euler and Bernoulli, conſidered as mathematical diſſertations, and they are wonderful works of genius, conſidered as the productions of perſons who hardly ever ſaw a ſhip, and were totally unacquainted with the profeſſion of a ſeaman. In this reſpect Bouguer had great ſuperiority, having always lived at a ſea port, and having made many very long voyages. His treatiſes therefore are infinitely better accommodated to the demands of the ſeaman, and more directly inſtructive; but ſtill the author is more a mathematician than an artiſt, and his performance is intelligible only to mathematicians. It is true, the academical education of the young gentlemen of the French navy is ſuch, that a great number of them may acquire the preparatory knowledge that is neceſſary; and we are well informed that, in this reſpect, the officers of the Britiſh navy are greatly inferior to them.

5 Argument againſt the utility of their performances,

But this very circumſtance has furniſhed to many perſons an argument againſt the utility of thoſe performances. It is ſaid that, "notwithſtanding this ſuperior mathematical education, and the poſſeſſion of thoſe boaſted performances of M. Bouguer, the French are greatly inferior, in point of ſeamanſhip, to our countrymen, who have not a page in their language to inſtruct them, and who could not peruſe it if they had it." Nay, ſo little do the French themſelves ſeem ſenſible of the advantage of theſe publications, that no perſon among them has attempted to make a familiar abridgement of them, written in a way fitted to attract attention; and they ſtill remain neglected in their original abſtruſe and unintereſting form.

We wiſh that we could give a ſatisfactory anſwer to this obſervation. It is juſt, and it is important. Theſe very ingenious and learned diſſertations are by no means ſo uſeful as we ſhould expect. They are large books, and appear to contain much; and as their plan is logical, it ſeems to occupy the whole ſubject, and therefore to have done almoſt all that can be done. But, alas! they have only opened the ſubject, and the ſtudy is yet in its infancy. The whole ſcience of the art muſt proceed on the knowledge of the impulſions of the wind and water. Theſe are the forces which act on the machine; and its motions, which are the ultimatum of our reſearch, whether as an end to be obtained or as a thing to be prevented, muſt depend on theſe forces. Now it is with reſpect to this fundamental point that we are as yet almoſt totally in the dark. And, in the performances of M. Bouguer, as alſo in thoſe of the other authors we have named, the theory of theſe forces, by which their quantity and the direction of their action are aſcertained, is altogether erroneous; and its reſults deviate ſo enormouſly from what is obſerved in the motions of a ſhip, that the perſon who ſhould direct the operations on ſhipboard, in conformity to the maxims deducible from M. Bouguer's propoſitions, would be baffled in moſt of his attempts, and be in danger of loſing the ſhip. The whole proceeds on the ſuppoſed truth of that theory which ſtates the impulſe of a fluid to be in the proportion of the ſquare of the ſine of the angle of incidence; and that its action on any ſmall portion, ſuch as a ſquare foot of the ſails or hull, is the ſame as if that portion were detached from the reſt, and were expoſed, ſingle and alone, to the wind or water in the ſame angle. But we have ſhown, in the article *RESISTANCE of Fluids*, both from theory and experience, that both of theſe principles are erroneous, and this to a very great degree, in caſes which occur moſt frequently in practice, that is, in the ſmall angles of inclination. When the wind falls nearly perpendicular on the ſails, theory is not very erroneous: but in theſe caſes, the circumſtances of the ſhip's ſituation are generally ſuch that the practice is eaſy, occurring almoſt without thought; and in this caſe, too, even conſiderable deviations from the very beſt practice are of no great moment. The intereſting caſes, where the intended movement requires or depends upon very oblique actions of the wind on the ſails, and its practicability or impracticability depends on a very ſmall variation of this obliquity; a miſtake of the force, either as to intenſity or direction, produces a mighty effect on the reſulting motion. This is the caſe in ſailing to windward; the moſt important of all the general problems of ſeamanſhip. The trim of the ſails, and the courſe of the ſhip, ſo as to gain moſt on the wind, are very nice things; that is, they are confined within very narrow limits, and a ſmall miſtake produces a very conſiderable effect. The ſame thing obtains in many of the nice problems

6 which are confeſſedly erroneous in their fundamental principles;

blems of tacking, box-hauling, wearing after lying to in a ftorm, &c.

The error in the fecond affertion of the theory is ftill greater, and the action on one part of the fail or hull is fo greatly modified by its action on another adjoining part, that a ftay-fail is often feen hanging like a loofe rag, although there is nothing between it and the wind ; and this merely becaufe a great fail in its neighbourhood fends off a lateral ftream of wind, which completely hinders the wind from getting at it. Till the theory of the action of fluids be eftablifhed, therefore, we cannot tell what are the forces which are acting on every point of the fail and hull : Therefore we cannot tell either the mean intenfity or direction of the whole force which acts on any particular fail, nor the intenfity and mean direction of the refiftance to the hull ; circumftances abfolutely neceffary for enabling us to fay what will be their energy in producing a rotation round any particular axis. In like manner, we cannot, by fuch a computation, find the fpontaneous axis of converfion (fee ROTATION), or the velocity of fuch converfion. In fhort, we cannot pronounce with tolerable confidence *à priori* what will be the motions in any cafe, or what difpofitions of the fails will produce the movement we wifh to perform. The experienced feaman learns by habit the general effects of every difpofition of the fails ; and though his knowledge is far from being accurate, it feldom leads him into any very blundering operation. Perhaps he feldom makes the beft adjuftment poffible, but feldomer ftill does he deviate very far from it ; and in the moft general and important problems, fuch as working to windward, the refult of much experience and many corrections has fettled a trim of the fails, which is certainly not far from the truth, but (it muft be acknowledged) deviates widely and uniformly from the theories of the mathematician's clofet, The honeft tar, therefore, muft be indulged in his joke on the ufelefs labours of the mathematician, who can neither hand, reef, nor fteer.

After this account of the theoretical performances in the art of feamanfhip, and what we have faid in another place on the fmall hopes we entertain of feeing a perfect theory of the impulfe of fluids, it will not be expected that we enter very minutely on the fubject in this place ;

7 Though ufe may be made of them.

nor is it our intention. But let it be obferved, that the theory is defective in one point only ; and although this is a moft important point, and the errors in it deftroy the conclufions of the chief propofitions, the reafonings remain in full force, and the *modus operandi* is precifely fuch as is ftated in the theory. The *principles* of the art are therefore to be found in thefe treatifes ; but falfe inferences have been drawn, by computing from erroneous quantities. The rules and the practice of the computation, however, are ftill beyond controverfy : Nay, fince the procefs of inveftigation is legitimate, we may make ufe of it in order to difcover the very circumftance in which we are at prefent miftaken : for by converting the propofition, inftead of finding the motions by means of the fuppofed forces, combined with the known mechanifm, we may difcover the forces by means of this mechanifm and the obferved motions.

8 Defign of the article.

We fhall therefore in this place give a very general view of the movements of a fhip under fail, fhowing how they are produced and modified by the action of the wind on her fails, the water on her rudder and on her bows. We fhall not attempt a precife determination of any of thefe movements ; but we fhall fay enough to enable the curious landfman to underftand how this mighty machine is managed amidft the fury of the winds and waves : and, what is more to our wifh, we hope to enable the uninftructed but thinking feaman to generalife that knowledge which he poffeffes ; to clafs his ideas, and give them a fort of rational fyftem ; and even to improve his practice, by making him fenfible of the immediate operation of every thing he does, and in what manner it contributes to produce the movement which he has in view.

9 A fhip confidered as in free fpace impelled and refifted by oppofite forces.

A fhip may be confidered at prefent as a mafs of inert matter in free fpace, at liberty to move in every direction, according to the forces which impel or refift her : and when fhe is in actual motion, in the direction of her courfe, we may ftill confider her as at reft in abfolute fpace, but expofed to the impulfe of a current of water moving equally faft in the oppofite direction : for in both cafes the preffure of the water on her bows is the fame ; and we know that it is poffible, and frequently happens in currents, that the impulfe of the wind on her fails, and that of the water on her bows, balance each other fo precifely, that fhe not only does not ftir from the place, but alfo remains fteadily in the fame pofition, with her head directed to the fame point of the compafs. This ftate of things is eafily conceived by any perfon accuftomed to confider mechanical fubjects, and every feaman of experience has obferved it. It is of importance to confider it in this point of view, becaufe it gives us the moft familiar notion of the manner in which thefe forces of the wind and water are fet in oppofition, and made to balance or not to balance each other by the intervention of the fhip, in the fame manner as the goods and the weights balance each other in the fcales by the intervention of a beam or fteelyard.

10 Impulfe of the wind on the fails oppofite to that of the water on the bows.

When a fhip proceeds fteadily in her courfe, without changing her rate of failing, or varying the direction of her head, we muft in the firft place conceive the accumulated impulfes of the wind on all her fails as precifely equal and directly oppofite to the impulfe of the water on her bows. In the next place, becaufe the fhip does not change the direction of her keel, fhe refembles the balanced fteelyard, in which the energies of the two weights, which tend to produce rotations in oppofite directions, and thus to change the pofition of the beam, mutually balance each other round the fulcrum ; fo the energies of the actions of the wind on the different fails balance the energies of the water on the different parts of the hull.

The feaman has two principal tafks to perform. The firft is to keep the fhip fteadily in that courfe which will bring her artheft on in the line of her intended voyage. This is frequently very different from that line, and the choice of the beft courfe is fometimes a

11 Skill of the feaman difplayed in fhaping his courfe.

matter of confiderable difficulty. It is fometimes poffible to fhape the courfe precifely along the line of the voyage ; and yet the intelligent feaman knows that he will arrive fooner, or with greater fafety, at his port, by taking a different courfe ; becaufe he will gain more by increafing his fpeed than he lofes by increafing the diftance. Some principle muft direct him in the felection of this courfe. This we muft attempt to lay before the reader.

Having chofen fuch a courfe as he thinks moft advantageous,

tageous, he muſt ſet ſuch a quantity of ſail as the ſtrength of the wind will allow him to carry with ſafety and effect, and muſt trim the ſails properly, or ſo adjuſt their poſitions to the direction of the wind, that they may have the greateſt poſſible tendency to impel the ſhip in the line of her courſe, and to keep her ſteadily in that direction.

His other taſk is to produce any deviations which he ſees proper from the preſent courſe of the ſhip; and to produce theſe in the moſt certain, the ſafeſt, and the moſt expeditious manner. It is chiefly in this movement that the mechanical nature of a ſhip comes into view, and it is here that the ſuperior addreſs and reſource of an expert ſeaman is to be perceived.

Under the article SAILING ſome notice has been taken of the firſt taſk of the ſeaman, and it was there ſhown how a ſhip, after having taken up her anchor and fitted her ſails, accelerates her motion, by degrees which continually diminiſh, till the increaſing reſiſtance of the water becomes preciſely equal to the diminiſhed impulſe of the wind, and then the motion continues uniformly the ſame ſo long as the wind continues to blow with the ſame force and in the ſame direction.

It is perfectly conſonant to experience that the impulſe of fluids is in the duplicate ratio of the relative velocity. Let it be ſuppoſed that when water moves one foot per ſecond, its perpendicular preſſure or impulſe on a ſquare foot is m pounds. Then, if it be moving with the velocity V eſtimated in feet per ſecond, its perpendicular impulſe on a ſurface S, containing any number of ſquare feet, muſt be $m\,SV^2$.

In like manner, the impulſe of air on the ſame ſurface may be repreſented by $n\,S\,V^2$; and the proportion of the impulſe of theſe two fluids will be that of m to n. We may expreſs this by the ratio of q to 1, making

$$\frac{m}{n} = q.$$

12 Impulſe of the water computed in ounces on the ſquare foot.

M. Bouguer's computations and tables are on the ſuppoſition that the impulſe of ſea-water moving one foot per ſecond is 23 ounces on a ſquare foot, and that the impulſe of the wind is the ſame when it blows at the rate of 24 feet per ſecond. Theſe meaſures are all French. They by no means agree with the experiments of others; and what we have already ſaid, when treating of the *RESISTANCE of Fluids*, is enough to ſhow us that nothing like preciſe meaſures can be expected. It was ſhown as the reſult of a rational inveſtigation, and confirmed by the experiments of Buat and others, that the impulſions and reſiſtances at the ſame ſurface, with the ſame obliquity of incidence and the ſame velocity of motion, are different according to the form and ſituation of the adjoining parts. Thus the total reſiſtance of a thin board is greater than that of a long priſm, having this board for its front or bow, &c.

We are greatly at a loſs what to give as abſolute meaſures of theſe impulſions.

1. With reſpect to water. The experiments of the French academy on a priſm two feet broad and deep and four feet long, indicate a reſiſtance of 0,973 pounds avoirdupois to a ſquare foot, moving with the velocity of one foot per ſecond at the ſurface of ſtill water.

Mr Buat's experiments on a ſquare foot wholly immerſed in a ſtream were as follow:

A ſquare foot as a thin plate -	1,81 pounds.
Ditto as the front of a box one foot long - - - -	1,42
Ditto as the front of a box three feet long - - - -	1,29

The reſiſtance of ſea-water is about $\frac{1}{35}$ greater.

2. With reſpect to air, the varieties are as great.—The reſiſtance of a ſquare foot to air moving with the velocity of one foot per ſecond appears from Mr Robins's experiments on 16 ſquare inches to be on a

ſquare foot - - -	0,001596 pounds,
Chevalier Borda's on 16 inches	0,001757
——————— on 81 inches	0,002042
Mr Rouſe's on large ſurfaces	0,002291

Preciſe meaſures are not to be expected, nor are they neceſſary in this inquiry. Here we are chiefly intereſted in their proportions, as they may be varied by their mode of action in the different circumſtances of obliquity and velocity.

We begin by recurring to the fundamental propoſition concerning the impulſe of fluids, viz. that the abſolute preſſure is always in a direction perpendicular to the impelled ſurface, whatever may be the direction of the ſtream of fluid. We muſt therefore illuſtrate the doctrine, by always ſuppoſing a flat ſurface of ſail ſtretched on a yard, which can be braced about in any direction, and giving this ſail ſuch a poſition and ſuch an extent of ſurface that the impulſe on it may be the ſame both as to direction and intenſity with that on the real ſails. Thus the conſideration is greatly ſimplified. The direction of the impulſe is therefore perpendicular to the yard. Its intenſity depends on the velocity with which the wind meets the ſail, and the obliquity of its ſtroke. We ſhall adopt the conſtructions founded on the common doctrine, that the impulſe is as the ſquare of the ſine of the inclination, becauſe they are ſimple; whereas, if we were to introduce the values of the oblique impulſes, ſuch as they have been obſerved in the excellent experiments of the Academy of Paris, the conſtructions would be complicated in the extreme, and we could hardly draw any conſequences which would be intelligible to any but expert mathematicians. The concluſions will be erroneous, not in kind but in quantity only; and we ſhall point out the neceſſary corrections, ſo that the final reſults will be found not very different from real obſervation.

13 Direction of the impulſe on the ſail perpendicular to the yard.

If a ſhip were a round cylindrical body like a flat tub, floating on its bottom, and fitted with a maſt and ſail in the centre, ſhe would always ſail in a direction perpendicular to the yard. This is evident. But ſhe is an oblong body, and may be compared to a cheſt, whoſe length greatly exceeds its breadth. She is ſo ſhaped, that a moderate force will puſh her through the water with the head or ſtern foremoſt; but it requires a very great force to puſh her ſidewiſe with the ſame velocity. A fine ſailing ſhip of war will require about 12 times as much force to puſh her ſidewiſe as to puſh her head foremoſt. In this reſpect therefore ſhe will very much reſemble a cheſt whoſe length is 12 times its breadth; and whatever be the proportion of theſe reſiſtances in different ſhips, we may always ſubſtitute a box which ſhall have the ſame reſiſtances headwiſe and ſidewiſe.

14 A ſhip compared to an oblong box.

Let LFGH (fig. 1.) be the horizontal ſection of ſuch

Plate CCCCLXXXIX Fig. 1. ſuch a box, and AB its middle line, and C its centre. In whatever direction this box may chance to move, the direction of the whole reſiſtance on its two ſides will paſs through C. For as the whole ſtream has one inclination to the ſide EF, the equivalent of the equal impulſes on every part will be in a line perpendicular to the middle of EF. For the ſame reaſon, it will be in a line perpendicular to the middle of FG. Theſe perpendiculars muſt croſs in C. Suppoſe a maſt erected at C, and YC y to be a yard hoiſted on it carrying a ſail. Let the yard be firſt conceived as braced right athwart at right angles to the keel, as repreſented by $Y' y'$. Then, whatever be the direction of the wind abaft this ſail, it will impel the veſſel in the direction CB. But if the ſail has the oblique poſition Y y, the impulſe will be in the direction CD perpendicular to CY, and will both puſh the veſſel ahead and ſidewiſe: For the impulſe CD is equivalent to the two impulſes CK and CI (the ſides of a rectangle of which CD is the diagonal). The force CI puſhes the veſſel ahead, and CK puſhes her ſidewiſe. She muſt therefore take ſome intermediate direction a b, ſuch that the reſiſtance of the water to the plane FG is to its reſiſtance to the plane EF as CI to CK.

15 Makes leeway when not ſailing directly before the wind.

The angle b CB between the real courſe and the direction of the head is called the LEEWAY; and in the courſe of this diſſertation we ſhall expreſs it by the ſymbol x. It evidently depends on the ſhape of the veſſel and on the poſition of the yard. An accurate knowledge of the quantity of leeway, correſponding to different circumſtances of obliquity of impulſe, extent of ſurface, &c. is of the utmoſt importance in the practice of navigation; and even an approximation is valuable. The ſubject is ſo very difficult that this muſt content us for the preſent.

16 How to find the quantity of leeway,

Let V be the velocity of the ſhip in the direction C b, and let the ſurfaces FG and FE be called A' and B'. Then the reſiſtance to the lateral motion is $m\,V^2 \times B' \times$ ſine ^{2}, bCB, and that to the direct motion is $mV^2 \times A' \times$ ſine ^{2}, bCK, or $m\,V^2 \times A' \times$ coſ.$^2 b$CB. Therefore theſe reſiſtances are in the proportion of $B' \times$ ſine^2. x to $A' \times$ coſ.^{2}, x (repreſenting the angle of leeway b CB by the ſymbol x).

Therefore we have CI : CK, or CI : ID $= A' \cdot$ coſ. $^2 x$: $B' \cdot$ ſine^2 x, $= A' : B' \cdot \frac{\text{ſine}^2\ x}{\text{coſ.}^2\ x} = A : B \cdot$ tangent ^{2} x.

Let the angle YCB, to which the yard is braced up, be called the TRIM of the ſails, and expreſſed by the ſymbol b. This is the complement of the angle DCI. Now CI : ID = rad. : tan. DCI, = 1 : tan. DCI, = 1 : cotan. b. Therefore we have finally 1 : cotan. $b = A' : B' \cdot$ tan ^{2} x, and $A' \cdot$ cotan. $b = B' \cdot$ tangent ^{2} x, and tan. ^{2} $x = \frac{A}{B}$ cot. b. This equation evidently aſcertains the mutual relation between the trim of the ſails and the leeway in every caſe where we can tell the proportion between the reſiſtances to the direct and broadſide motions of the ſhip, and where this proportion does not change by the obliquity of the courſe. Thus, ſuppoſe the yard braced up to an angle of 30° with the keel. Then cotan. 30° = 1,732 very nearly. Suppoſe alſo that the reſiſtance ſidewiſe is 12 times greater than the reſiſtance headwiſe. This gives $A' = 1$ and $B' = 12$. Therefore $1{,}732 = 12 \times$ tangent ^{2} x, and tangent ^{2} $x = \frac{1{,}732}{12}, = 0{,}14434$, and tan. $x = 0{,}3799$, and $x = 20°\ 48'$, very nearly two points of leeway.

This computation, or rather the equation which gives room for it, ſuppoſes the reſiſtances proportional to the ſquares of the ſines of incidence. The experiments of the Academy of Paris, of which an abſtract is given in the article *RESISTANCE of Fluids*, ſhow that this ſuppoſition is not far from the truth when the angle of incidence is great. In the preſent caſe the angle of incidence on the front FG is about 70°, and the experiments juſt now mentioned ſhow that the real reſiſtances exceed the theoretical ones only $\frac{1}{180}$. But the angle of incidence on EF is only 20° 48′. Experiment ſhows that in this inclination the reſiſtance is almoſt quadruple of the theoretical reſiſtances. Therefore the lateral reſiſtance is aſſumed much too ſmall in the preſent inſtance. Therefore a much ſmaller leeway will ſuffice for producing a lateral reſiſtance which will balance the lateral impulſe CK, ariſing from the obliquity of the ſail, viz. 30°. The matter of fact is, that a pretty good ſailing ſhip, with her ſails braced to this angle at a medium, will not make above five or ſix degrees leeway in ſmooth water and eaſy weather; and yet in this ſituation the hull and rigging preſent a very great ſurface to the wind, in the moſt improper poſitions, ſo as to have a very great effect in increaſing her leeway. And if we compute the reſiſtances for this leeway of ſix degrees by the actual experiments of the French Academy on the angle, we ſhall find the reſult not far from the truth; that is, the direct and lateral reſiſtances will be nearly in the proportion of CI to ID.

It reſults from this view of the matter, that the leeway is in general much ſmaller than what the uſual theory aſſigns.

17 which depends on the trim of the ſails.

We alſo ſee, that according to whatever law the reſiſtances change by a change of inclination, the leeway remains the ſame while the trim of the ſails is the ſame. The leeway depends only on the direction of the impulſe of the wind; and this depends ſolely on the poſition of the ſails with reſpect to the keel, whatever may be the direction of the wind. This is a very important obſervation, and will be frequently referred to in the progreſs of the preſent inveſtigation. Note, however, that we are here conſidering only the action on the ſails, and on the ſame ſails. We are not conſidering the action of the wind on the hull and rigging. This may be very conſiderable; and it is always in a lee direction, and augments the leeway; and its influence muſt be ſo much the more ſenſible as it bears a greater proportion to the impulſe on the ſails. A ſhip under courſes, or cloſe-reefed topſails and courſes, muſt make more leeway than when under all her canvas trimmed, to the ſame angle. But to introduce this additional cauſe of deviation here would render the inveſtigation too complicated to be of any uſe.

18 Illuſtration of this doctrine by experiments.

This doctrine will be conſiderably illuſtrated by attending to the manner in which a lighter is tracked along a canal, or ſwings to its anchor in a ſtream. The track rope is made faſt to ſome ſtaple or bolt E on the deck (fig. 2.), and is paſſed between two of the timber-heads of the bow D, and laid hold of at F on ſhore. The men or cattle walk along the path FG, the rope Fig. 2.

keeps

keeps extended in the directions DF, and the lighter arranges itself in an oblique position AB, and is thus dragged along in the direction $a\,b$, parallel to the side of the canal. Or, if the canal has a current in the opposite direction $b\,a$, the lighter may be kept steady in its place by the rope DF made fast to a post at F. In this case, it is always observed, that the lighter swings in a position AB, which is oblique to the stream $a\,b$. Now the force which retains it in this position, and which precisely balances the action of the stream, is certainly exerted in the direction DF; and the lighter would be held in the same manner if the rope were made fast at C amidship, without any dependence on the timberheads at D; and it would be held in the same position, if, instead of the single rope CF, it were riding by two ropes CG and CH, of which CH is in a direction right ahead, but oblique to the stream, and the other CG is perpendicular to CH or AB. And, drawing DI and DK perpendicular to AB and CG, the strain on the rope CH is to that on the rope CG as CI to CK. The action of the rope in these cases is precisely analogous to that of the sail y Y; and the obliquity of the keel to the direction of the motion, or to the direction of the stream, is analogous to the leeway. All this must be evident to any person accustomed to mechanical disquisitions.

19
On models and

A most important use may be made of this illustration. If an accurate model be made of a ship, and if it be placed in a stream of water, and ridden in this manner by a rope made fast at any point D of the bow, it will arrange itself in some determined position AB. There will be a certain obliquity to the stream, measured by the angle B$o\,b$; and there will be a corresponding obliquity of the rope, measured by the angle FCB. Let y CY be perpendicular to CF. Then CY will be the position of the yard, or trim of the sails corresponding to the leeway b CB. Then, if we shift the rope to a point of the bow distant from D by a small quantity, we shall obtain a new position of the ship, both with respect to the stream and rope; and in this way may be obtained the relation between the position of the sails and the leeway, independent of all theory, and susceptible of great accuracy; and this may be done with a variety of models suited to the most usual forms of ships.

20
on ships.
Fig. 3.

In farther thinking on this subject, we are persuaded that these experiments, instead of being made on models, may with equal ease be made on a ship of any size. Let the ship ride in a stream at a mooring D (fig. 3.) by means of a short hawser BCD from her bow, having a spring AC on it carried out from her quarter. She will swing to her moorings, till she ranges herself in a certain position AB with respect to the direction $a\,b$ of the stream; and the direction of the hawser DC will point to some point E of the line of the keel. Now, it is plain to any person acquainted with mechanical disquisitions, that the deviation BEb is precisely the leeway that the ship will make when the average position of the sails is that of the line GEH perpendicular to ED; at least this will give the leeway which is produced by the sails alone. By heaving on the spring, the knot C may be brought into any other position we please; and for every new position of the knot the ship will take a new position with respect to the stream and to the hawser. And we persist in saying, that more information will be got by this train of experiments than from any mathematical theory: for all the theories of the impulses of fluids must proceed on physical postulates with respect to the motions of the filaments, which are exceedingly conjectural.

21
The comparison of a ship to an oblong body is only useful to give clear notions on the subject.

And it must now be farther observed, that the substitution which we have made of an oblong parallelopiped for a ship, although well suited to give us clear notions of the subject, is of small use in practice: for it is next to impossible (even granting the theory of oblique impulsions) to make this substitution. A ship is of a form which is not reducible to equations; and therefore the action of the water on her bow or broadside can only be had by a most laborious and intricate calculation for almost every square foot of its surface. (See *Bezout's Cours de Mathem.* vol. v. p. 72, &c.) And this must be different for every ship. But, which is more unlucky, when we have got a parallelopiped which will have the same proportion of direct and lateral resistance for a particular angle of leeway, it will not answer for another leeway of the same ship; for when the leeway changes, the figure actually exposed to the action of the water changes also. When the leeway is increased, more of the lee-quarter is acted on by the water, and a part of the weather-bow is now removed from its action. Another parallelopiped must therefore be discovered, whose resistances shall suit this new position of the keel with respect to the real course of the ship.

We therefore beg leave to recommend this train of experiments to the notice of the ASSOCIATION FOR THE IMPROVEMENT OF NAVAL ARCHITECTURE as a very promising method for ascertaining this important poinr. And we proceed, in the next place, to ascertain the relation between the velocity of the ship and that of the wind, modified as they may be by the trim of the sails and the obliquity of the impulse.

22
The relation between the velocity of the ship and wind ascertained.
Fig. 4.

Let AB (fig. 4, 5, and 6.) represent the horizontal section of a ship. In place of all the drawing sails, that is, the sails which are really filled, we can always substitute one sail of equal extent, trimmed to the same angle with the keel. This being supposed attached to the yard DCD, let this yard be first of all at right angles to the keel, as represented in fig. 4. Let the wind blow in the direction WC, and let CE (in the direction WC continued) represent the velocity V of the wind. Let CF be the velocity v of the ship. It must also be in the direction of the ship's motion, because when the sail is at right angles to the keel, the absolute impulse on the sail is in the direction of the keel, and there is no lateral impulse, and consequently no leeway. Draw EF, and complete the parallelogram CFEe, producing eC through the centre of the yard to w. Then wC will be the relative or apparent direction of the wind, and Ce or FE will be its apparent or relative velocity: For if the line Ce be carried along CF, keeping always parallel to its first position, and if a particle of air move uniformly along CE (a fixed line in absolute space) in the same time, this particle will always be found in that point of CE where is is intersected at that instant by the moving line C; so that if Ce were a tube, the particle of air, which really moves in the line CE, would always be found in the tube Ce. While CE is the real direction of the wind, Ce will be the position of the vane

vane at the mast head, which will therefore mark the apparent direction of the wind, or its motion relative to the moving ship.

We may conceive this in another way. Suppose a cannon-shot fired in the direction CE at the passing ship, and that it passes through the mast at C with the velocity of the wind. It will not pass through the off-side of the ship at P, in the line CE: for while the shot moves from C to P, the point P has gone forward, and the point p is now in the place where P was when the shot passed through the mast. The shot will therefore pass through the ship's side in the point p, and a person on board seeing it pass through C and p will say that its motion was in the line Cp.

23 When a ship is in motion the apparent direction of the wind is always different from the real direction.

Thus it happens, that when a ship is in motion the apparent direction of the wind is always ahead of its real direction. The line w C is always found within the angle WCB. It is easy to see from the construction, that the difference between the real and apparent directions of the wind is so much the more remarkable as the velocity of the ship is greater: For the angle WC w or EC e depends on the magnitude of E e or CF, in proportion to CE. Persons not much accustomed to attend to these matters are apt to think all attention to this difference to be nothing but affectation of nicety. They have no notion that the velocity of a ship can have any sensible proportion to that of the wind. "Swift as the wind" is a proverbial expression; yet the velocity of a ship always bears a very sensible proportion to that of the wind, and even very frequently exceeds it. We may form a pretty exact notion of the velocity of the wind by observing the shadows of the summer clouds flying along the face of a country, and it may be very well measured by this method. The motion of such clouds cannot be very different from that of the air below; and when the pressure of the wind on a flat surface, while blowing with a velocity measured in this way, is compared with its pressure when its velocity is measured by more unexceptionable methods, they are found to agree with all desirable accuracy. Now observations of this kind frequently repeated, show that what we call a pleasant brisk gale blows at the rate of about 10 miles an hour, or about 15 feet in a second, and exerts a pressure of half a pound on a square foot. Mr Smeaton has frequently observed the sails of a windmill, driven by such a wind, moving faster, nay much faster, towards their extremities, so that the sail, instead of being pressed to the frames on the arms, was taken aback, and fluttering on them. Nay, we know that a good ship, with all her sails set and the wind on the beam, will in such a situation sail above ten knots an hour in smooth water. There is an observation made by every experienced seaman, which shows this difference between the real and apparent directions of the wind very distinctly. When a ship that is sailing briskly with the wind on the beam tacks about, and then sails equally well on the other tack, the wind always appears to have shifted and come more ahead. This is familiar to all seamen. The seaman judges of the direction of the wind by the position of the ship's vanes. Suppose the ship sailing due west on the starboard tack, with the wind apparently N. N. W. the vane pointing S. S. E. If the ship put about, and stands due east on the larboard tack, the vane will be found no longer to point S. S. E. but perhaps S.S.W. the wind appearing N.N.E. and the ship must be nearly close-hauled in order to make an east course. The wind appears to have shifted four points. If the ship tacks again, the wind returns to its old quarter. We have often observed a greater difference than this. The celebrated astronomer Dr Bradley, taking the amusement of sailing in a pinnace on the river Thames, observed this, and was surprised at it, imagining that the change of wind was owing to the approaching to or retiring from the shore. The boatmen told him that it always happened at sea, and explained it to him in the best manner they were able. The explanation struck him, and set him a musing on an astronomical phenomenon which he had been puzzled by for some years, and which he called THE ABERRATION OF THE FIXED STARS. Every star changes its place a small matter for half a year, and returns to it at the completion of the year. He compared the stream of light from the star to the wind, and the telescope of the astronomer to the ship's vane, while the earth was like the ship, moving in opposite directions when in the opposite points of its orbit. The telescope must always be pointed ahead of the real direction of the star, in the same manner as the vane is always in a direction ahead of the wind; and thus he ascertained the progressive motion of light, and discovered the proportion of its velocity to the velocity of the earth in its orbit, by observing the deviation which was necessarily given to the telescope. Observing that the light shifted its direction about 40″, he concluded its velocity to be about 11,000 times greater than that of the earth; just as the intelligent seaman would conclude from this apparent shifting of the wind, that the velocity of the wind is about triple that of the ship. This is indeed the best method for discovering the velocity of the wind. Let the direction of the vane at the mast-head be very accurately noticed on both tacks, and let the velocity of the ship be also accurately measured. The angle between the directions of the ship's head on these different tacks being halved, will give the real direction of the wind, which must be compared with the position of the vane in order to determine the angle contained between the real and apparent directions of the wind or the angle EC e; or half of the observed shifting of the wind will show the inclination of its true and apparent directions. This being found, the proportion of EC to FC (fig. 6.) is easily measured.

24 Observation of Dr Bradley on this subject.

We have been very particular on this point, because since the mutual actions of bodies depend on their relative motions only, we should make prodigious mistakes if we estimated the action of the wind by its real direction and velocity, when they differ so much from the relative or apparent.

25 Velocity of a ship when its sails are at right angles to the keel.

We now resume the investigation of the velocity of the ship (fig. 4.), having its sails at right angles to the keel, and the wind blowing in the direction and with the velocity CE, while the ship proceeds in the direction of the keel with the velocity CF. Produce E e, which is parallel to BC, till it meet the yard in g, and draw FG perpendicular to E g. Let a represent the angle WCD, contained between the sail and the real direction of the wind, and let b be the angle of trim DCB. Let the velocity of the wind was expressed by V, and CF the velocity of the ship by v.

The absolute impulse on the sail is (by the usual theory

theory) proportional to the ſquare of the relative velocity, and to the ſquare of the ſine of the angle of incidence; that is, to $FE^2 \times \text{ſin.}^2\, w\, CD$. Now the angle $GFE = w\, CD$, and EG is equal to $FE \times \text{ſin.}\ GFE$; and EG is equal to $Eg - gG$. But $Eg = EC \times \text{ſin.}\ ECg, = V \times \text{ſin.}\ a$; and $gG = CF, = v$. Therefore $EG = V \times \text{ſin.}\ a - v$, and the impulſe is proportional to $\overline{V \times \text{ſin.}\ a - v}^2$. If S repreſent the ſurface of the ſail, the impulſe, in pounds, will be $n\, S(V \times \text{ſin.}\ a - v)^2$.

Let A be the ſurface which, when it meets the water perpendicularly with the velocity v, will ſuſtain the ſame preſſure or reſiſtance which the bows of the ſhip actually meets with. This impulſe, in pounds, will be $m\, A\, v^2$. Therefore, becauſe we are conſidering the ſhip's motion as in a ſtate of uniformity, the two preſſures balance each other; and therefore $m\, A\, v^2 = n\, S\, (V \times \text{ſin.}\ a - v)^2$, and $\frac{m}{n}\, A\, v^2 = S\ (V \times \text{ſin.}\ a - v)^2$;

therefore $\sqrt{\frac{m}{n}}\, \sqrt{A} \times v = \sqrt{S} \times V \times \text{ſin.}\ a - v\sqrt{S}$, and

$$v = \frac{\sqrt{S} \times v \times \text{ſin.}\ a}{\sqrt{\frac{m}{n}A} + \sqrt{S}} = \frac{V \times \text{ſin.}\ a}{\sqrt{\frac{m A}{n S}} + 1} = \frac{V \times \text{ſin.}\ a}{\sqrt{q\frac{A}{S}} + 1}.$$

We ſee, in the firſt place, that the velocity of the ſhip is *(cæteris paribus)* proportional to the velocity of the wind, and to the ſine of its incidence on the ſail jointly; for while the ſurface of the ſail S and the equivalent ſurface for the bow remains the ſame, v increaſes or diminiſhes at the ſame rate with $V \cdot \text{ſin.}\ a$.— When the wind is right aſtern, the ſine of a is unity, and then the ſhip's velocity is $\frac{V}{\sqrt{\frac{m A}{n S}} + 1}$.

Note, that the denominator of this fraction is a common number; for m and n are numbers, and A and S being quantities of one kind, $\frac{A}{S}$ is alſo a number.

It muſt alſo be carefully attended to, that S expreſſes a quantity of ſail actually receiving wind with the inclination a. It will not always be true, therefore, that the velocity will increaſe as the wind is more abaft, becauſe ſome ſails will then becalm others. This obſervation is not, however, of great importance; for it is very unuſual to put a ſhip in the ſituation conſidered hitherto; that is, with the yards ſquare, unleſs ſhe be right before the wind.

If we would diſcover the relation between the velocity and the quantity of ſail in this ſimple caſe of the wind right aft, obſerve that the equation $v = \frac{V}{\sqrt{\frac{m A}{n S}} + 1}$ gives us $\sqrt{\frac{m A}{n S}}\, v + v = V$, and $\sqrt{\frac{m A}{n S}}\ v = V - v$, and $\frac{m A}{n S} v^2 = \overline{V - v}^2$, and $\frac{n S}{m A} = \frac{v^2}{(V - v)^2}$; and becauſe n and m and A are conſtant quantities, S is proportional to $\frac{v^2}{(V - v)^2}$, or the ſurface of ſail is proportional to the ſquare of the ſhip's velocity directly, and to the ſquare of the relative velocity inverſely. Thus, if a ſhip be ſailing with one-eighth of the velocity of the wind, and we would have her ſail with one-fourth of it, we muſt quadruple the ſail. This is more eaſily ſeen in another way. The velocity of the ſhip is proportional to the velocity of the wind; and therefore the relative velocity is alſo proportional to that of the wind, and the impulſe of the wind is as the ſquare of the relative velocity. Therefore, in order to increaſe the relative velocity by an increaſe of ſail only, we muſt make this increaſe of ſail in the duplicate proportion of the increaſe of velocity.

Let us, in the next place, conſider the motion of a ſhip whoſe ſails ſtand oblique to the keel. 26

Its velocity when the ſails ſtand oblique to the keel.

The conſtruction for this purpoſe differs a little from the former, becauſe, when the ſails are trimmed to any oblique poſition DCB (fig. 5. and 6.), there muſt be a deviation from the direction of the keel, or a leeway BC b. Call this x. Let CF be the velocity of the ſhip. Draw, as before, Eg perpendicular to the yard, and FG perpendicular to Eg; alſo draw FH perpendicular to the yard: then, as before, EG, which is in the ſubduplicate ratio of the impulſe on the ſail, is equal to $Eg - Gg$. Now Eg is, as before, $= V \times \text{ſin.}\ a$, and G$g$ is equal to FH, which is $= CF \times \text{ſin.}\ FCH$, or $= v \times \text{ſin.}\ (b + x)$. Therefore we have the impulſe $= n\, S\ (V \cdot \text{ſin.}\ a - v \cdot \text{ſin.}\ (b + x)^2$. Fig. 5. and 6.

This expreſſion of the impulſe is perfectly ſimilar to that in the former caſe, its only difference conſiſting in the ſubductive part, which is here $v \times \text{ſin.}\ \overline{b + x}$ inſtead of v. But it expreſſes the ſame thing as before, viz. the diminution of the impulſe. The impulſe being reckoned ſolely in the direction perpendicular to the ſail, it is diminiſhed ſolely by the ſail withdrawing itſelf *in that direction* from the wind; and as g E may be conſidered as the real impulſive motion of the wind, GE muſt be conſidered as the relative and effective impulſive motion. The impulſe would have been the ſame had the ſhip been at reſt, and had the wind met it perpendicularly with the velocity GE.

27

Connection between the impulſe and motion of the ſhip.

We muſt now ſhow the connection between this impulſe and the motion of the ſhip. The ſail, and conſequently the ſhip, is preſſed by the wind in the direction CI perpendicular to the ſail or yard with the force which we have juſt now determined. This (in the ſtate of uniform motion) muſt be equal and oppoſite to the action of the water. Draw IL at right angles to the keel. The impulſe in the direction CI (which we may meaſure by CI) is equivalent to the impulſes CL and LI. By the firſt the ſhip is impelled right forward, and by the ſecond ſhe is driven ſidewiſe. Therefore we muſt have a leeway, and a lateral as well as a direct reſiſtance. We ſuppoſe the form of the ſhip to be known, and therefore the proportion is known, or diſcoverable, between the direct and lateral reſiſtances correſponding to every angle x of leeway. Let A be the ſurface whoſe perpendicular reſiſtance is equal to the direct reſiſtance of the ſhip correſponding to the leeway x, that is, whoſe reſiſtance is equal to the reſiſtance really felt by the ſhip's bows in the direction of the keel when ſhe is ſailing with this leeway; and let B in like manner be the ſurface whoſe perpendicular reſiſtance is equal to the actual reſiſtance to the ſhip's motion in the direction LI, perpendicular to the keel. (*N. B.* This is not equivalent to A and B′ adapted to the rectangular box, but to $A' \cdot \text{coſ.}^2\ x$ and $B' \cdot \text{ſin.}^2\ x$.) We have therefore

therefore A : B = CL : LI, and $LI = \frac{CL \cdot B}{A}$. Also, because $CI = \sqrt{CL^2 + LI^2}$, we have $A : \sqrt{A^2 + B^2} = CL : CI$, and $CI = \frac{CL \cdot \sqrt{A^2+B^2}}{A}$. The resistance in the direction LC is properly measured by $m\,A\,v^2$, as has been already observed. Therefore the resistance in the direction IC must be expressed by $m\,\sqrt{A^2+B^2}\,v^2$; or (making C the surface which is equal to $\sqrt{A^2+B^2}$, and which will therefore have the same perpendicular resistance to the water having the velocity v) it may be expressed by $m\,C\,v^2$.

Therefore, because there is an equilibrium between the impulse and resistance, we have $m\,C\,v^2 = n\,S\,(V \cdot \text{sin.}\,a - v \cdot \text{sin.}\,\overline{b+x})^2$ and $\frac{m}{n}\,C\,v^2$, or $q\,C\,v^2 = S\,(V \cdot \text{sin.}\,a - v \cdot \text{sin.}\,\overline{b+x})^2$, and $\sqrt{q}\,\sqrt{C}\,v = \sqrt{S}\,(V \cdot \text{sin.}\,a - v \cdot \text{sin.}\,\overline{b+x})$.

$$\text{Therefore } v = \frac{\sqrt{S} \cdot V \cdot \text{sin.}\,a}{\sqrt{q}\,\sqrt{C} + \sqrt{S} \cdot \text{sin.}\,\overline{b+x}}, = \frac{V \cdot \text{sin.}\,a}{\sqrt{q}\,\frac{\sqrt{C}}{\sqrt{S}} + \text{sin.}\,\overline{b+x}}, = V\,\frac{\text{Sin.}\,a}{\sqrt{q}\,\frac{\sqrt{C}}{\sqrt{S}} + \text{sin.}\,\overline{b+x}}.$$

Observe that the quantity which is the coefficient of V in this equation is a common number; for sin. a is a number, being a decimal fraction of the radius 1, Sin. $\overline{b+x}$ is also a number, for the same reason. And since m and n were numbers of pounds, $\frac{m}{n}$ or q is a common number. And because C and S are surfaces, or quantities of one kind, $\frac{C}{S}$ is also a common number.

This is the simplest expression that we can think of for the velocity acquired by the ship, though it must be acknowledged to be too complex to be of very prompt use. Its complication arises from the necessity of introducing the leeway x. This affects the whole of the denominator; for the surface C depends on it, because C is $= \sqrt{A^2+B^2}$, and A and B are analogous to A' cos. $^2 x$ and B' sin. $^2 x$.

28 Important consequences deduced from the foregoing theorem.

But we can deduce some important consequences from this theorem.

While the surface S of the sail actually filled by the wind remains the same, and the angle DCB, which in future we shall call the TRIM of the sails, also remains the same, both the leeway x and the substituted surface C remains the same. The denominator is therefore constant; and the velocity of the ship is proportional to $\sqrt{S} \cdot V \cdot \text{sin.}\,a$; that is, directly as the velocity of the wind, directly as the absolute inclination of the wind to the yard, and directly as the square root of the surface of the sails.

We also learn from the construction of the figure that FG parallel to the yard cuts CE in a given ratio. For CF is in a constant ratio to Eg, as has been just now demonstrated. And the angle DCF is constant. Therefore CF · sin. b, or FH or Gg, is proportional to Eg, and OC to EC, or EC is cut in one proportion, whatever may be the angle ECD, so long as the angle DCF is constant.

We also see that it is very possible for the velocity of the ship on an oblique course to exceed that of the wind. This will be the case when the number $\frac{\text{sin.}\,a}{\sqrt{q\frac{C}{S}} + \text{sin.}\,\overline{b+x}}$ exceeds unity, or when sin. a is greater than $\sqrt{q\frac{C}{S}} + \text{sin.}\,\overline{b+x}$. Now this may easily be by sufficiently enlarging S and diminishing $b+x$. It is indeed frequently seen in fine sailers with all their sails set and not hauled too near the wind.

We remarked above that the angle of leeway x affects the whole denominator of the fraction which expresses the velocity. Let it be observed that the angle ICL is the complement of LCD, or of b. Therefore, CL : LI, or A : B = 1 : tan. ICL, = 1 : cot. b, and B = A · cotan. b. Now A is equivalent to $A' \cdot$ cos. $^2 x$, and thus b becomes a function of x. C is evidently so, being $\sqrt{A^2+B^2}$. Therefore before the value of this fraction can be obtained, we must be able to compute, by our knowledge of the form of the ship, the value of A for every angle x of leeway. This can be done only by resolving her bows into a great number of elementary planes, and computing the impulses on each and adding them into one sum. The computation is of immense labour, as may be seen by one example given by Bouguer. When the leeway is but small, not exceeding ten degrees, the substitution of the rectangular prism of one determined form is abundantly exact for all leeways contained within this limit; and we shall soon see reason for being contented with this approximation. We may now make use of the formula expressing the velocity for solving the chief problems in this part of the seaman's task.

29 Problem I. To determine the best position of the sails for standing on a given course, when the direction and velocity of the wind and its angle with the course are given.

And first let it be required to determine the best position of the sail for standing on a given course $a\,b$, when CE the direction and velocity of the wind, and its angle with the course WCF, are given. This problem has exercised the talents of the mathematicians ever since the days of Newton. In the article PNEUMATICS we gave the solution of one very nearly related to it, namely, to determine the position of the sail which would produce the greatest impulse in the direction of the course. The solution was to place the yard CD in such a position that the tangent of the angle FCD may be one half of the tangent of the angle DCW. This will indeed be the best position of the sail for beginning the motion; but as soon as the ship begins to move in the direction CF, the effective impulse of the wind is diminished, and also its inclination to the sail. The angle DCw diminishes continually as the ship accelerates; for CF is now accompanied by its equal e E, and by an angle ECe or WCw. CF increases, and the impulse on the sail diminishes, till an equilibrium obtains between the resistance of the water and the impulse of the wind. The impulse is now measured by CE² × sin.² eCD instead of CE² × sin.² ECD, that is, by EG² instead of Eg^2.

This introduction of the relative motion of the wind renders the actual solution of the problem extremely difficult.

difficult. It is very easily expressed geometrically: Divide the angle wCF in such a manner that the tangent of DCF may be half of the tangent of DCw, and the problem may be constructed geometrically as follows.

Fig. 7. Let WCF (fig. 7.) be the angle between the sail and course. Round the centre C describe the circle WDFY; produce WC to Q, so that CQ$=\frac{1}{3}$WC, and draw QY parallel to CF cutting the circle in Y; bisect the arch WY in D, and draw DC. DC is the proper position of the yard.

Draw the chord WY, cutting CD in V and CF in T; draw the tangent PD cutting CF in S and CY in R.

It is evident that WY, PR. are both perpendicular to CD, and are bisected in V and D; therefore (by reason of the parallels QY, CF) $1:3=$ QW : CW, $=$YW : TW, $=$RP : SP. Therefore PD : PS$=2:3$, and PD : DS $=2:1$. *Q. E. D.* But this division cannot be made to the best advantage till the ship has attained its greatest velocity, and the angle wCF has been produced.

We must consider all the three angles, a, b, and x, as variable in the equation which expresses the value of v, and we must make the fluxion of this equation $=o$; then, by means of the equation $B=A\cdot$ cotan. b, we must obtain the value of b and of $\dot{b}$ in terms of x and $\dot{x}$. With respect to a, observe, that if we make the angle WCF$=p$, we have $p=a+b+x$; and p being a constant quantity, we have $\dot{a}+\dot{b}+\dot{x}=o$. Substituting for a, b, $\dot{a}$, and $\dot{b}$, their values in terms of x and $\dot{x}$, in the fluxionary equation $=o$, we readily obtain x, and then a and b, which solves the problem.

Let it be required, in the next place, to determine the course and the trim of the sails most proper for plying to windward.

30 Problem II. To determine the course and trim of the sails most proper for plying to windward.

In fig. 6. draw FP perpendicular to WC. CF is the motion of the ship; but it is only by the motion PC that she gains to windward. Now CP is $=$ CF $\times$ cosin. WCF, or $v\cdot$ cosin. $(a+b+x)$. This must be rendered a maximum, as follows.

By means of the equation which expresses the value of v and the equation $B=A\cdot$ cotan. b, we exterminate the quantities v and b; we then take the fluxion of the quantity into which the expression $v\cdot$ cos. $(a+b+x)$ is changed by this operation. Making this fluxion $=o$, we get the equation which must solve the problem. This equation will contain the two variable quantities a and x with their fluxions; then make the coefficient of $\dot{x}$ equal to o, also the coefficient of $\dot{a}$ equal to o. This will give two equations which will determine a and x, and from this we get $b=p-a-x$.

31 Problem III. To determine the best course and trim of the sails for getting away from a given line of coast.

Should it be required, in the third place, to find the best course and trim of the sails for getting away from a given line of coast CM (fig. 6.), the process perfectly resembles this last, which is in fact getting away from a line of coast which makes a right angle with the wind. Therefore, in place of the angle WCF, we must substitute the angle WCM$\pm$WCF. Call this angle e. We must make $v\cdot$ cos. $(e\pm a\pm b\pm x)$ a maximum. The analytical process is the same as the former, only e is here a constant quantity.

32 Observations on the preceding problems.

These are the three principal problems which can be solved by means of the knowledge that we have obtained of the motion of the ship when impelled by an oblique sail, and therefore making leeway; and they may be considered as an abstract of this part of M. Bouguer's work. We have only pointed out the process for this solution, and have even omitted some things taken notice of by M. Bezout in his very elegant compendium. Our reasons will appear as we go on. The learned reader will readily see the extreme difficulty of the subject, and the immense calculations which are necessary even in the simplest cases, and will grant that it is out of the power of any but an expert analyst to derive any use from them; but the mathematician can calculate tables for the use of the practical seaman. Thus he can calculate the best position of the sails for advancing in a course 90° from the wind, and the velocity in that course;

33 M. Bouguer's table for finding the best position of the sails for advancing in any course.

then for 85°, 80°, 75°, &c. M. Bouguer has given a table of this kind; but to avoid the immense difficulty of the process, he has adapted it to the apparent direction of the wind. We have inserted a few of his numbers, suited to such cases as can be of service, namely, when all the sails draw, or none stand in the way of others. Column 1st is the apparent angle of the wind and course; column 2d is the corresponding angle of the sails and keel; and column 3d is the apparent angle of the sails and wind.

1 wCF	2 DCB	3 wCD
103° 53′	42° 30′	61° 23′
99 13	40 —	59 13
94 25	37 30	56 55
89 28	35 —	54 28
84 23	32 30	51 53
79 06	30 —	49 06
73 39	27 30	46 09
68 —	25 —	43 —

In all these numbers we have the tangent of wCD double of the tangent of DCF.

34 Inutility of these calculations.

But this is really doing but little for the seaman. The apparent direction of the wind is unknown to him till the ship is sailing with uniform velocity; and he is still uninformed as to the leeway. It is, however, of service to him to know, for instance, that when the angle of the vanes and yards is 56 degrees, the yard should be braced up to 37° 30′, &c.

But here occurs a new difficulty. By the construction of a square-rigged ship it is impossible to give the yards that inclination to the keel which the calculation requires. Few ships can have their yards braced up to 37° 30′; and yet this is required in order to have an incidence of 56°, and to hold a course 94° 25′ from the apparent direction of the wind, that is, with the wind apparently 4° 25′ abaft the beam. A good sailing ship in this position may acquire a velocity even exceeding that of the wind. Let us suppose it only one half of this velocity. We shall find that the angle WCw is in this case about 29°, and the ship is nearly going 123° from the wind, with the wind almost perpendicular to the sail; therefore this utmost bracing up of the sails is only giving them the position suited to a wind broad on the quarter. It is impossible therefore to comply with the demand of the mathematician, and the seaman must be contented to employ a less favourable disposition of his sails in all cases where his course does not lie at least eleven points from the wind.

 Let

Let us fee whether this reftriction, arifing from neceffity, leaves any thing in our choice, and makes one courfe preferable to another. We fee that there are a prodigious number of courfes, and thefe the moft ufual and the moft important, which we muft hold with one trim of the fails; in particular, failing with the wind on the beam, and all cafes of plying to windward, muft be performed with this unfavourable trim of the fails. We are certain that the fmaller we make the angle of incidence, real or apparent, the fmaller will be the velocity of the fhip; but it may happen that we fhall gain more to windward, or get fooner away from a lee-coaft, or any object of danger, by failing flowly on one courfe than by failing quickly on another.

We have feen that while the trim of the fails remains the fame, the leeway and the angle of the yard and courfe remains the fame, and that the velocity of the fhip is as the fine of the angle of real incidence, that is, as the fine of the angle of the fail and the real direction of the wind.

Fig. 8. Let the fhip AB (fig. 8.) hold the courfe CF, with the wind blowing in the direction WC, and having her yards DCD braced up to the fmalleft angle BCD which the rigging can admit. Let CF be to CE as the velocity of the fhip to the velocity of the wind; join FE and draw C w parallel to EF; it is evident that FE is the relative motion of the wind, and w CD is the relative incidence on the fail. Draw FO parallel to the yard DC, and defcribe a circle through the points COF; then we fay that if the fhip, with the fame wind and the fame trim of the fame drawing fails, be made to fail on any other courfe Cf, her velocity along CF is to the velocity along Cf as CF is to Cf; or, in other words, the fhip will employ the fame time in going from C to any point of the circumference CFO.

Join fO. Then, becaufe the angles CFO, cfO are on the fame chord CO, they are equal, and fO is parallel to dCd, the new pofition of the yard correfponding to the new pofition of the keel ab, making the angle dCb=DCB. Alfo, by the nature of the circle, the line CF is to Cf as the fine of the angle CFO to the fine of the angle COf, that is (on account of the parallels CD, OF and Cd, Of), as the fine of WCD to the fine of WCd. But when the trim of the fails remains the fame, the velocity of the fhip is as the fine of the angle of the fail with the direction of the wind; therefore CF is to Cf as the velocity on CF to that on Cf, and the propofition is demonftrated.

35 To determine the beft courfe for avoiding a rock.

Let it now be required to determine the beft courfe for avoiding a rock R lying in the direction CR, or for withdrawing as faft as poffible from a line of coaft PQ. Draw CM through R, or parallel to PQ, and let m be the middle of the arch C m M. It is plain that m is the moft remote from CM of any point of the arch C m M, and therefore the fhip will recede farther from the coaft PQ in any given time by holding the courfe C m than by any other courfe.

This courfe is eafily determined; for the arch CmM $=360^\circ$ — (arch CO + arch OM), and the arch CO is the meafure of twice the angle CFO, or twice the angle DCB, or twice $\overline{b+x}$, and the arch OM meafures twice the angle ECM.

Thus, fuppofe the fharpeft poffible trim of the fails to be 35°, and the obferved angle ECM to be 70°; then CO+OM is $70^\circ+140^\circ$ or 210°. This being taken from 360°, leaves 150°, of which the half M m is 75°, and the angle MC m is $37^\circ\ 30'$. This added to ECM makes ECm $107^\circ\ 30'$, leaving WC m=$72^\circ\ 30'$, and the fhip muft hold a courfe making an angle of $72^\circ\ 30'$ with the real direction of the wind, and WCD will be $37^\circ\ 30'$.

This fuppofes no leeway. But if we know that under all the fail which the fhip can carry with fafety and advantage fhe makes 5 degrees of leeway, the angle DC m of the fail and courfe, or $b+x$, is 40°. Then CO+OM=220°, which being taken from 360° leaves 140°, of which the half is 70°, =M m, and the angle MC $m=35^\circ$, and EC $m=105^\circ$, and WC $m=75^\circ$, and the fhip muft lie with her head 70° from the wind, making 5 degrees of leeway, and the angle WCD is 35°.

The general rule for the pofition of the fhip is, *that the line on fhipboard which bifects the angle* b+x *may alfo bifect the angle* WCM, or make the angle between the courfe and the line from which we wifh to withdraw equal to the angle between the fail and the real direction of the wind.

36 Corollaries.

It is plain that this problem includes that of plying to windward. We have only to fuppofe ECM to be 90°; then, taking our example in the fame fhip, with the fame trim and the fame leeway, we have $b+x=40^\circ$. This taken from 90° leaves 50° and WCn=90—25=65, and the fhip's head muft lie 60° from the wind, and the yard muft be 25° from it.

It muft be obferved here, that it is not always eligible to felect the courfe which will remove the fhip fafteft from the given line CM; it may be more prudent to remove from it more fecurely though more flowly. In fuch cafes the procedure is very fimple, viz. to fhape the courfe as near the wind as is poffible.

The reader will alfo eafily fee that the propriety of thefe practices is confined to thofe courfes only where the practicable trim of the fails is not fufficiently fharp. Whenever the courfe lies fo far from the wind that it is poffible to make the tangent of the apparent angle of the wind and fail double the tangent of the fail and courfe, it fhould be done.

37 The adjuftment of the fails fuppofed in the theory impracticable.

Thefe are the chief practical confequences which can be deduced from the theory. But we fhould confider how far this adjuftment of the fails and courfe can be performed. And here occur difficulties fo great as to make it almoft impracticable. We have always fuppofed the pofition of the furface of the fail to be diftinctly obfervable and meafurable; but this can hardly be affirmed even with refpect to a fail ftretched on a yard. Here we fuppofed the furface of the fail to have the fame inclination to the keel that the yard has. This is by no means the cafe; the fail affumes a concave form, of which it is almoft impoffible to affign the direction of the mean impulfe. We believe that this is always confiderably to leeward of a perpendicular to the yard, lying between CI and CE (fig. 6.). This is of fome advantage, being equivalent to a fharper trim. We cannot affirm this, however, with any confidence, becaufe it renders the impulfe on the weather-leech of the fail fo exceedingly feeble as hardly to have any effect. In failing clofe to the wind the fhip is kept fo near that the weather-leech of the fail is almoft ready to receive the wind edgewife, and to flutter or fhiver. The moft effective or drawing fails with a fide-wind, efpecially when

when plying to windward, are the staysails. We believe that it is impossible to say, with any thing approaching to precision, what is the position of the general surface of a staysail, or to calculate the intensity and direction of the general impulse; and we affirm with confidence that no man can pronounce on these points with any exactness. If we can guess within a third or a fourth part of the truth, it is all we can pretend to; and after all, it is but a guess. Add to this, the sails coming in the way of each other, and either becalming them or sending the wind upon them in a direction widely different from that of its free motion. All these points we think beyond our power of calculation, and therefore that it is in vain to give the seaman mathematical rules, or even tables of adjustment ready calculated; since he can neither produce that medium position of his sails that is required, nor tell what is the position which he employs.

This is one of the principal reasons why so little advantage has been derived from the very ingenious and promising disquisitions of Bouguer and other mathematicians, and has made us omit the actual solution of the chief problems, contenting ourselves with pointing out the process to such readers as have a relish for these analytical operations.

38 The theory itself erroneous,

But there is another principal reason for the small progress which has been made in the theory of seamanship: This is the error of the theory itself, which supposes the impulsions of a fluid to be in the duplicate ratio of the sine of incidence. The most careful comparison which has been made between the results of this theory and matter of fact is to be seen in the experiments made by the members of the Royal Academy of Sciences at Paris, mentioned in the article *RESISTANCE of Fluids*. We subjoin another abstract of them in the following table; where col. 1st gives the angle of incidence; col. 2d gives the impulsions really observed; col. 3d the impulses, had they followed the duplicate ratio of the sines; and col. 4th the impulses, if they were in the simple ratio of the sines.

Angle of incid.	Impulsion observed	Impulse as Sine ².	Impulse as Sine.
90	1000	1000	1000
84	989	989	995
78	958	957	978
72	908	905	951
66	845	835	914
60	771	750	866
54	693	655	809
48	615	552	743
42	543	448	669
36	480	346	587
30	440	250	500
24	424	165	407
18	414	96	309
12	406	43	208
6	400	11	105

Here we see an enormous difference in the great obliquities. When the angle of incidence is only six degrees, the observed impulse is forty times greater than the theoretical impulse, at 12° it is ten times greater; at 18° it is more than four times greater; and at 24° it is almost three times greater.

No wonder then that the deductions from this theory are so useless and so unlike what we familiarly observe. 39 and the deductions from it useless.
We took notice of this when we were considering the leeway of a rectangular box, and thus saw a reason for admitting an incomparably smaller leeway than what would result from the laborious computations necessary by the theory. This error in theory has as great an influence on the impulsions of air when acting obliquely on a sail; and the experiments of Mr Robins and of the Chevalier Borda on the oblique impulsions of air are perfectly conformable (as far as they go) to those of the academicians on water. The oblique impulsions of the wind are therefore much more efficacious for pressing the ship in the direction of her course than the theory allows us to suppose; and the progress of a ship plying to windward is much greater, both because the oblique impulses of the wind are more effective, and because the leeway is much smaller, than we suppose. Were not this the case, it would be impossible for a square-rigged ship to get to windward. The impulse on her sails when close hauled would be so trifling that she would not have a third part of the velocity which we see her acquire: and this trifling velocity would be wasted in leeway; for we have seen that the diminution of the oblique impulses of the water is accompanied by an increase of leeway. But we see that in the great obliquities the impulsions continue to be very considerable, and that even an incidence of six degrees gives an impulse as great as the theory allows to an incidence of 40. We may therefore, on all occasions, keep the yards more square; and the loss which we sustain by the diminution of the very oblique impulse will be more than compensated by its more favourable direction with respect to the ship's keel. Let us take an example of this. Suppose the wind about two points before the beam, making an angle of 68° with the keel. The theory assigns 43° for the inclination of the wind to the sail, and 15° for the trim of the sail. The perpendicular impulse being supposed 1000, the theoretical impulse for 45° is 465. This reduced in the proportion of radius to the sine of 25°, gives the impulse in the direction of the course only 197.

But if we ease off the lee-braces till the yard makes an angle of 50° with the keel, and allows the wind an incidence of no more than 18°, we have the experimented impulse 414, which, when reduced in the proportion of radius to the sine of 50°, gives an effective impulse 317. In like manner, the trim 56°, with the incidence 12°, gives an effective impulse 337; and the trim 62°, with the incidence only 6°, gives 353.

Hence it would at first sight appear that the angle DCB of 62° and WCD of 6° would be better for holding a course within six points of the wind than any more oblique position of the sails; but it will only give a greater initial impulse. As the ship accelerates, the wind apparently comes ahead, and we must continue to brace up as the ship freshens her way. It is not unusual for her to acquire half or two thirds of the velocity of the wind; in which case the wind comes apparently ahead more than two points, when the yards must be braced up to 35°, and this allows an impulse no greater than about 7°. Now this is very frequently

observed

obſerved in good ſhips, which in a briſk gale and ſmooth water will go five or ſix knots cloſe-hauled, the ſhip's head ſix points from the wind, and the ſails no more than juſt full, but ready to ſhiver by the ſmalleſt luff. All this would be impoſſible by the uſual theory; and in this reſpect theſe experiments of the French academy gave a fine illuſtration of the ſeaman's practice. They account for what we ſhould otherwiſe be much puzzled to explain; and the great progreſs which is made by a ſhip cloſe hauled being perfectly agreeable to what we ſhould expect from the law of oblique impulſion deducible from theſe ſo often mentioned experiments, while it is totally incompatible with the common theory, ſhould make us abandon the theory without heſitation, and ſtrenuouſly ſet about the eſtabliſhment of another, founded entirely on experiments.

40
Experiments proper for eſtabliſhing another

For this purpoſe the experiments ſhould be made on the oblique impulſions of air on as great a ſcale as poſſible, and in as great a variety of circumſtances, ſo as to furniſh a ſeries of impulſions for all angles of obliquity. We have but four or five experiments on this ſubject, *viz.* two by Mr Robins and two or three by the Chevalier Borda. Having thus gotten a ſeries of impulſions, it is very practicable to raiſe on this foundation a practical inſtitute, and to give a table of the velocities of a ſhip ſuited to every angle of inclination and of trim; for nothing is more certain than the reſolution of the impulſe perpendicular to the ſail into a force in the direction of the keel, and a lateral force.

We are alſo diſpoſed to think that experiments might be made on a model very nicely rigged with ſails, and trimmed in every different degree, which would point out the mean direction of the impulſe on the ſails, and the comparative force of theſe impulſes in different directions of the wind. The method would be very ſimilar to that for examining the impulſe of the water on the hull. If this can alſo be aſcertained experimentally, the intelligent reader will eaſily ſee that the whole motion of a ſhip under ſail may be determined for every caſe. Tables may then be conſtructed by calculation, or by graphical operations, which will give the velocities of a ſhip in every different courſe, and correſponding to every trim of ſail. And let it be here obſerved, that the trim of the ſail is not to be eſtimated in degrees of inclination of the yards; becauſe, as we have already remarked, we cannot obſerve nor adjuſt the lateen ſails in this way. But, in making the experiments for aſcertaining the impulſe, the exact poſition of the tacks and ſheets of the ſails are to be noted; and this combination of adjuſtments is to paſs by the name of a certain trim. Thus that trim of all the ſails may be called 40, whoſe direction is experimentally found equivalent to a flat ſurface trimmed to the obliquity 40°.

Having done this, we may conſtruct a figure for each trim ſimilar to fig. 8. where, inſtead of a circle, we ſhall have a curve C O M′ F′, whoſe chords CF′, *c f*′, &c. are proportional to the velocities in theſe courſes; and by means of this curve we can find the point *m*′, which is moſt remote from any line CM from which we wiſh to withdraw: and thus we may ſolve all the principal problems of the art.

We hope that it will not be accounted preſumption in us to expect more improvement from a theory founded on judicious experiments only, than from a theory of the impulſe of fluids, which is found ſo inconſiſtent with obſervation, and of whoſe fallacy all its authors, from Newton to D'Alembert, entertained ſtrong ſuſpicions. Again, we beg leave to recommend this view of the ſubject to the attention of the SOCIETY FOR THE IMPROVEMENT OF NAVAL ARCHITECTURE. 41

41
Recommended to the Society for the Improvement of Naval Architecture.

Should theſe patriotic gentlemen entertain a favourable opinion of the plan, and honour us with their correſpondence, we will cheerfully impart to them our notions of the way in which both theſe trains of experiments may be proſecuted with ſucceſs, and reſults obtained in which we may confide; and we content ourſelves at preſent with offering to the public theſe hints, which are not the ſpeculations of a man of mere ſcience, but of one who, with a competent knowledge of the laws of mechanical nature, has the experience of ſeveral years ſervice in the royal navy, where the art of working of ſhips was a favourite object of his ſcientific attention.

With theſe obſervations we conclude our diſcuſſion of the firſt part of the ſeaman's taſk, and now proceed to conſider the means that are employed to prevent or to produce any deviations from the uniform rectilineal courſe which has been ſelected. 42

42
Means employed to prevent or produce deviations from a courſe.

Here the ſhip is to be conſidered as a body in free ſpace, convertible round her centre of inertia. For whatever may be the point round which ſhe turns, this motion may always be conſidered as compounded of a rotation round an axis paſſing through her centre of gravity or inertia. She is impelled by the wind and by the water acting on many ſurfaces differently inclined to each other, and the impulſe on each is perpendicular to the ſurface. In order therefore that ſhe may continue ſteadily in one courſe, it is not only neceſſary that the impelling forces, eſtimated in their mean direction, be equal and oppoſite to the reſiſting forces eſtimated in their mean direction; but alſo that theſe two directions may paſs through one point, otherwiſe ſhe will be affected as a log of wood is when puſhed in oppoſite directions by two forces, which are equal indeed, but are applied to different parts of the log. A ſhip muſt be conſidered as a lever, acted on in different parts by forces in different directions, and the whole balancing each other round that point or axis where the equivalent of all the reſiſting forces paſſes. This may be conſidered as a point ſupported by this reſiſting force and as a ſort of fulcrum: therefore, in order that the ſhip may maintain her poſition, the energies or *momenta* of all the impelling forces round this point muſt balance each other.

When a ſhip ſails right afore the wind, with her yards ſquare, it is evident that the impulſes on each ſide of the keel are equal, as alſo their mechanical *momenta* round any axis paſſing perpendicularly through the keel. So are the actions of the water on her bows. But when ſhe ſails on an oblique courſe, with her yards braced up on either ſide, ſhe ſuſtains a preſſure in the direction CI (fig. 5.) perpendicular to the ſail. This, by giving her a lateral preſſure LI, as well as a preſſure CL ahead, cauſes her to make leeway, and to move in a line C *b* inclined to CB. By this means the balance of action on the two bows is deſtroyed; the general impulſe on the lee-bow is increaſed; and that on the weather-bow is diminiſhed. 43

43
Impulſes on a ſhip ſailing right before the wind different from thoſe on her when ſailing obliquely.

miniſhed. The combined impulſe is therefore no longer in the direction BC, but (in the ſtate of uniform motion) in the direction IC.

Suppoſe that in an inſtant the whole ſails are annihilated and the impelling preſſure CI, which preciſely balanced the reſiſting preſſure on the bows, removed. The ſhip tends, by her inertia, to proceed in the direction Cb. This tendency produces a continuation of the reſiſtance in the oppoſite direction IC, which is not directly oppoſed to the tendency of the ſhip in the direction Cb; therefore the ſhip's head would immediately come up to the wind. The experienced ſeamen will recollect ſomething like this when the ſails are ſuddenly lowered when coming to anchor. It does not happen ſolely from the obliquity of the action on the bows: It would happen to the parallelopiped of fig. 2. which was ſuſtaining a lateral impulſion $B \cdot \text{ſin.}^2 x$, and a direct impulſion $A \cdot \text{coſ.}^2 x$. Theſe are continued for a moment after the annihilation of the ſail: but being no longer oppoſed by a force in the direction CD, but by a force in the direction Cb, the force $B \cdot \text{ſin.}^2 x$ muſt prevail, and the body is not only retarded in its motion, but its head turns towards the wind. But this effect of the leeway is greatly increaſed by the curved form of the ſhip's bows. This occaſions the centre of effort of all the impulſions of the water on the leeſide of the ſhip to be very far forward, and this ſo much the more remarkably as ſhe is ſharper afore. It is in general not much abaft the foremaſt. Now the centre of the ſhip's tendency to continue her motion is the ſame with her centre of gravity, and this is generally but a little before the mainmaſt. She is therefore in the ſame condition nearly as if ſhe were puſhed at the mainmaſt in a direction parallel to Cb, and at the foremaſt by a force parallel to IC. The evident conſequence of this is a tendency to come up to the wind. This is independent of all ſituation of the ſails, provided only that they have been trimmed obliquely.

44 Griping.

This tendency of the ſhip's head to windward is called GRIPING in the ſeaman's language, and is greateſt in ſhips which are ſharp forward, as we have ſaid already. This circumſtance is eaſily underſtood. Whatever is the direction of the ſhip's motion, the abſolute impulſe on that part of the bow immediately contiguous to B is perpendicular to that very part of the ſurface. The more acute, therefore, that the angle of the bow is, the more will the impulſe on that part be perpendicular to the keel, and the greater will be its energy to turn the head to windward.

45 Propriety of the diſpoſition of the ſails of a ſhip.

Thus we are enabled to underſtand or to ſee the propriety of the diſpoſition of the ſails of a ſhip. We ſee her crowded with ſails forward, and even many ſails extended far before her bow, ſuch as the ſpritſail, the bowſprit-topſail, the fore-topmaſt ſtayſail, the jib, and flying jib. The ſails abaft are comparatively ſmaller. The ſails on the mizenmaſt are much ſmaller than thoſe on the foremaſt. All the ſtayſails hoiſted on the mainmaſt may be conſidered as headſails, becauſe their centres of effort are conſiderably before the centre of gravity of the ſhip: and notwithſtanding this diſpoſition, it generally requires a ſmall action of the rudder to counteract the windward tendency of the lee-bow. This is conſidered as a good quality when moderate; becauſe it enables the ſeaman to throw the ſails aback, and ſtop the ſhip's way in a moment, if ſhe be in danger from any thing a head; and the ſhip which does not carry a little of a weather helm, is always a dull ſailer.

46 Action of the water and the ſails.

In order to judge ſomewhat more accurately of the action of the water and ſails, ſuppoſe the ſhip A B (fig. 9.) to have its ſails on the mizenmaſt D, the mainmaſt E, and foremaſt F, braced up or trimmed alike, and that the three lines Di, Ee, Ff, perpendicular to the ſails, are in the proportion of the impulſes on the ſails. The ſhip is driven a-head and to leeward, and moves in the path aCb. This path is ſo inclined to the line of the keel that the medium direction of the reſiſtance of the water is parallel to the direction of the impulſe. A line CI may be drawn parallel to the lines Di, Ee, Ff, and equal to their ſum: and it may be drawn from ſuch a point C, that the actions on all the parts of the hull between C and B may balance the *momenta* of all the actions on the hull between C and A. This point may juſtly be called the *centre of effort*, or the *centre of reſiſtance*. We cannot determine this point for want of a proper theory of the reſiſtance of fluids. Nay, although experiments like thoſe of the Pariſian academy ſhould give us the moſt perfect knowledge of the intenſity of the oblique impulſes on a ſquare foot, we ſhould hardly be benefited by them: for the action of the water on a ſquare foot of the hull at p, for inſtance, is ſo modified by the intervention of the ſtream of water which has ſtruck the hull about B, and glided along the bow Bop, that the preſſure on p is totally different from what it would have been were it a ſquare foot or ſurface detached from the reſt, and preſented in the ſame poſition to the water moving in the direction bC. For it is found, that the reſiſtances given to planes joined ſo as to form a wedge, or to curved ſurfaces, are widely different from the accumulated reſiſtances, calculated for their ſeparate parts, agreeably to the experiments of the academy on ſingle ſurfaces. We therefore do not attempt to aſcertain the point C by theory; but it may be accurately determined by the experiments which we have ſo ſtrongly recommended; and we offer this as an additional inducement for proſecuting them.

Fig. 9.

47 Centre of effort

48 to be determined by experiments.

Draw through C a line perpendicular to CI, that is, parallel to the ſails; and let the lines of impulſe of the three ſails cut it in the points i, k, and m. This line im may be conſidered as a lever, moveable round C, and acted on at the points i, k, and m, by three forces. The rotatory momentum of the ſails on the mizenmaſt is $Di \times iC$; that of the ſails on the mainmaſt is $Ee \times kC$; and the momentum of the ſails on the foremaſt is $Ff \times mC$. The two firſt tend to preſs forward the arm Ci, and then to turn the ſhip's head towards the wind. The action of the ſails on the foremaſt tends to pull the arm Cm forward, and produce a contrary rotation. If the ſhip under theſe three ſails keeps ſteadily in her courſe, without the aid of the rudder, we muſt have $Di \times iC + Ee \times kC = Ff \times mC$. This is very poſſible, and is often ſeen in a ſhip under her mizen-topſail, main-topſail, and fore-topſail, all parallel to one another, and their ſurfaces duly proportioned by reefing. If more ſails are ſet, we muſt always have a ſimilar equilibrium. A certain number of them will have their efforts directed from the larboard arm of the lever im lying to leeward of CI, and a certain number will have their efforts directed from the ſtarboard arm lying to windward of CI. The ſum of the products of each of the firſt ſet, by their diſtances from C, muſt be equal

49 Equilibrium preſerved by the poſition of the ſails.

equal to the ſum of the ſimilar products of the other ſet. As this equilibrium is all that is neceſſary for preſerving the ſhip's poſition, and the ceſſation of it is immediately followed by a converſion; and as theſe ſtates of the ſhip may be had by means of the three ſquare ſails only, when their ſurfaces are properly proportioned—it is plain that every movement may be executed and explained by their means. This will greatly ſimplify our future diſcuſſions. We ſhall therefore ſuppoſe in future that there are only the three topſails ſet, and that their ſurfaces are ſo adjuſted by reefing, that their actions exactly balance each other round that point C of the middle line AB, where the actions of the water on the different parts of her bottom in like manner balance each other. This point C may be differently ſituated in the ſhip according to the leeway ſhe makes, depending on the trim of the ſails; and therefore although a certain proportion of the three ſurfaces may balance each other in one ſtate of leeway, they may happen not to do ſo in another ſtate. But the equilibrium is evidently attainable in every caſe, and we therefore ſhall always ſuppoſe it.

50
Conſequence of deſtroying it.

It muſt now be obſerved, that when this equilibrium is deſtroyed, as, for example, by turning the edge of the mizen-topſail to the wind, which the ſeamen call *ſhivering* the mizen-topſail, and which may be conſidered as equivalent to the removing the mizen-topſail entirely, it does not follow that the ſhip will round the point C, this point remaining fixed. The ſhip muſt be conſidered as a free body, ſtill acted on by a number of forces, which no longer balance each other; and ſhe muſt therefore *begin* to turn round a ſpontaneous axis of converſion, which muſt be determined in the way ſet forth in the article ROTATION. It is of importance to point out in general where this axis is ſituated. Therefore let G (fig. 10.) be the centre of gravity of the ſhip. Draw the line $q\,G\,v$ parallel to the yards, cutting $D\,d$ in q, $E\,e$ in r, CI in t, and $F\,f$ in v. While the three ſails are ſet, the line $q\,v$ may be conſidered as a lever acted on by four forces, *viz.* $D\,d$, impelling the lever forward perpendicularly in the point q; $E\,e$, impelling it forward in the point r; $F\,f$, impelling it forward in the point v; and CI, impelling it backward in the point t. Theſe forces balance each other both in reſpect of progreſſive motion and of rotatory energy: for CI was taken equal to the ſum of $D\,d$, $E\,e$, and $F\,f$; ſo that no acceleration or retardation of the ſhip's progreſs in her courſe is ſuppoſed.

Fig. 10.

But by taking away the mizen-topſail, both the equilibriums are deſtroyed. A part $D\,d$ of the accelerating force is taken away; and yet the ſhip, by her inertia or inherent force, tends, for a moment, to proceed in the direction $C\,p$ with her former velocity; and by this tendency exerts for a moment the ſame preſſure CI on the water, and ſuſtains the ſame reſiſtance IC. She muſt therefore be retarded in her motion by the exceſs of the reſiſtance IC over the remaining impelling forces $E\,e$ and $F\,f$, that is, by a force equal and oppoſite to $D\,d$. She will therefore be retarded in the ſame manner as if the mizen-topſail were ſtill ſet, and a force equal and oppoſite to its action were applied to G the centre of gravity, and ſhe would ſoon acquire a ſmaller velocity, which would again bring all things into equilibrium; and ſhe would ſtand on in the ſame courſe, without changing either her leeway or the poſition of her head.

But the equilibrium of the lever is alſo deſtroyed. It is now acted on by three forces only, *viz.* $E\,e$ and $F\,f$, impelling it forward in the points r and v, and IC impelling it backward in the point t. Make $r\,v : r\,o = E\,e + F\,f : F\,f$, and make $o\,p$ parallel to CI and equal to $E\,e = F\,f$. Then we know, from the common principles of mechanics, that the force $o\,p$ acting at o will have the ſame momentum or energy to turn the lever round *any* point whatever as the two forces $E\,e$ and $F\,f$ applied at r and v; and now the lever is acted on by two forces, *viz.* IC, urging it backwards in the point t, and $o\,p$ urging it forwards in the point o. It muſt therefore turn round like a floating log, which gets two blows in oppoſite directions. If we now make $IC - o\,p : o\,p = t\,o : t\,x$, or $IC - o\,p : IC = t\,o : o\,x$, and apply to the point x a force equal to $IC - o\,p$ in the direction IC; we know by the common principles of mechanics, that this force $IC - o\,p$ will produce the ſame rotation round any point as the two forces IC and $o\,p$ applied in their proper directions at t and o. Let us examine the ſituation of the point x.

The force $IC - o\,p$ is evidently $= D\,d$, and $o\,p$ is $= E\,e + F\,f$. Therefore $o\,t : t\,x = D\,d : o\,p$. But becauſe, when all the ſails were filled, there was an equilibrium round C, and therefore round t, and becauſe the force $o\,p$ acting at o is equivalent to $E\,e$ and $F\,f$ acting at r and v, we muſt ſtill have the equilibrium; and therefore we have the momentum $D\,d \times q\,t = o\,p \times o\,t$. Therefore $o\,t : t\,q = D\,d : o\,p$, and $t\,q = t\,x$. Therefore the point x is the ſame with the point q.

Therefore, when we ſhiver the mizen-topſail, the rotation of the ſhip is the ſame as if the ſhip were at reſt, and a force equal and oppoſite to the action of the mizen-topſail were applied at q or at D, or at any point in the line $D\,q$.

51
By ſhivering the mizen-topſail.

This might have been ſhown in another and ſhorter way. Suppoſe all ſails filled, the ſhip is in equilibrio. This will be diſturbed by applying to D a force oppoſite to $D\,d$; and if the force be alſo equal to $D\,d$, it is evident that theſe two forces deſtroy each other, and that this application of the force $d\,D$ is equivalent to the taking away of the mizen-topſail. But we choſe to give the whole mechanical inveſtigation; becauſe it gave us an opportunity of pointing out to the reader, in a caſe of very eaſy comprehenſion, the preciſe manner in which the ſhip is acted on by the different ſails and by the water, and what ſhare each of them has in the motion ultimately produced. We ſhall not repeat this manner of procedure in other caſes, becauſe a little reflection on the part of the reader will now enable him to trace the *modus operandi* through all its ſteps.

We now ſee that, in reſpect both of progreſſive motion and of converſion, the ſhip is affected by ſhivering the ſail D, in the ſame manner as if a force equal and oppoſite to $D\,d$ were applied at D, or at any point in the line $D\,d$. We muſt now have recourſe to the principles eſtabliſhed under the article ROTATION.

Let p repreſent a particle of matter, r its radius vector, or its diſtance $p\,G$ from an axis paſſing through the centre of gravity G, and let M repreſent the whole quantity of matter of the ſhip. Then its momentum of inertia is $= \int p \cdot r$ (ſee ROTATION, N° 18.) The ſhip, impelled in the point D by a force in the direction $d\,D$, will begin to turn round a ſpontaneous vertical axis, paſſing through a point S of the line $q\,G$, which

which is drawn through the centre of gravity G, perpendicular to the direction dD of the external force, and the distance GS of this axis from the centre of gravity is $=\frac{\int p \cdot r^2}{M \cdot Gq}$ (see ROTATION, N° 96.), and it is taken on the opposite side of G from q, that is, S and q are on opposite sides of G.

Let us express the external force by the symbol F. It is equivalent to a certain number of pounds, being the pressure of the wind moving with the velocity V and inclination a on the surface of the sail D; and may therefore be computed either by the theoretical or experimental law of oblique impulses. Having obtained this, we can ascertain the angular velocity of the rotation and the absolute velocity of any given point of the ship by means of the theorems established in the article ROTATION.

52 Action of the rudder. Fig. 11.

But before we proceed to this investigation, we shall consider the action of the rudder, which operates precisely in the same manner. Let the ship AB (fig. 11.) have her rudder in the position AD, the helm being hard a-starboard, while the ship sailing on the starboard tack, and making leeway, keeps on the course ab. The lee surface of the rudder meets the water obliquely. The very foot of the rudder meets it in the direction DE parallel to ab. The parts farther up meet it with various obliquities, and with various velocities, as it glides round the bottom of the ship and falls into the wake. It is absolutely impossible to calculate the accumulated impulse. We shall not be far mistaken in the deflection of each contiguous filament, as it quits the bottom and glides along the rudder; but we neither know the velocity of these filaments, nor the deflection and velocity of the filaments gliding without them. We therefore imagine that all computations on this subject are in vain. But it is enough for our purpose that we know the direction of the absolute pressure which they exert on its surface. It is in the direction Dd, perpendicular to that surface. We also may be confident that this pressure is very considerable, in proportion to the action of the water on the ship's bows, or of the wind on the sails; and we may suppose it to be nearly in the proportion of the square of the velocity of the ship in her course; but we cannot affirm it to be accurately in that proportion, for reasons that will readily occur to one who considers the way in which the water falls in behind the ship.

53 Greatest in a fine sailer.

It is observed, however, that a fine sailer always steers well, and that all movements by means of the rudder are performed with great rapidity when the velocity of the ship is great. We shall see by and by, that the speed with which the ship performs the angular movements is in the proportion of her progressive velocity: For we shall see that the squares of the times of performing the evolution are as the impulses inversely, which are as the squares of the velocities. There is perhaps no force which acts on a ship that can be more accurately determined by experiment than this. Let the ship ride in a stream or tideway whose velocity is accurately measured; and let her ride from two moorings, so that her bow may be a fixed point. Let a small tow-line be laid out from her stern or quarter at right angles to the keel, and connected with some apparatus fitted up on shore or on board another ship, by which the strain on it may be accurately measured; a person conversant with mechanics will see many ways in which this can be done. Perhaps the following may be as good as any: Let the end of the tow-line be fixed to some point as high out of the water as the point of the ship from which it is given out, and let this be very high. Let a block with a hook be on the rope, and a considerable weight hung on this hook. Things being thus prepared, put down the helm to a certain angle, so as to cause the ship to sheer off from the point to which the far end of the tow-line is attached. This will stretch the rope, and raise the weight out of the water. Now heave upon the rope, to bring the ship back again to her former position, with her keel in the direction of the stream. When this position is attained, note carefully the form of the rope, that is, the angle which its two parts make with the horizon. Call this angle a. Every person acquainted with these subjects knows that the horizontal strain is equal to half the weight multiplied by the cotangent of a, or that 2 is to the cotangent of a as the weight to the horizontal strain. Now it is this strain which balances and therefore measures the action of the rudder, or De in fig. 11. Therefore, to have the absolute impulse Dd, we must increase De in the proportion of radius to the secant of the angle b which the rudder makes with the keel. In a great ship sailing six miles in an hour, the impulse on the rudder inclined 30° to the keel is not less than 3000 pounds. The surface of the rudder of such a ship contains near 80 square feet. It is not, however, very necessary to know this absolute impulse Dd, because it is its part De alone which measures the energy of the rudder in producing a conversion. Such experiments, made with various positions of the rudder, will give its energies corresponding to these positions, and will settle that long disputed point, which is the best position for turning a ship. On the hypothesis that the impulsions of fluids are in the duplicate ratio of the sines of incidence, there can be no doubt that it should make an angle of 54° 44′ with the keel. But the form of a large ship will not admit of this, because a tiller of a length sufficient for managing the rudder in sailing with great velocity has not room to deviate above 30° from the direction of the keel; and in this position of the rudder the mean obliquity of the filaments of water to its surface cannot exceed 40° or 45°. A greater angle would not be of much service, for it is never for want of a proper obliquity that the rudder fails of producing a conversion.

54 How to determine it.

55 Why a ship misses stays, &c.

A ship misses stays in rough weather for want of a sufficient progressive velocity, and because her bows are beat off by the waves: and there is seldom any difficulty in wearing the ship, if she has any progressive motion. It is, however, always desirable to give the rudder as much influence as possible. Its surface should be enlarged (especially below) as much as can be done consistently with its strength and with the power of the steersmen to manage it; and it should be put in the most favourable situation for the water to get at it with great velocity; and it should be placed as far from the axis of the ship's motion as possible. These points are obtained by making the stern-post very upright, as has always been done in the French dockyards. The British ships have a much greater rake; but our builders are gradually adopting the French forms, experience having taught us that their ships, when in our possession, are much more obedient to the helm than our own.— In order to ascertain the motion produced by the action of the rudder, draw from the centre of gravity a line Gq perpendicular to Dd (Dd being drawn through the centre of effort of the rudder). Then, as in the consideration of the action of the sails, we may conceive the line qG as a lever connected with the ship, and impelled by a force Dd acting perpendicularly at q. The consequence of this will be, an incipient conversion of the ship about a vertical axis passing through some point S in the line qG, lying on the other side of G from q; and we have, as in the former case, $GS = \frac{\int p \cdot r^2}{M \cdot Gq}$.

56 The action of the rudder similar to that of the sails, and very great.

Thus the action and effects of the sails and of the rudder are perfectly similar, and are to be considered in the same manner. We see that the action of the rudder, though of a small surface in comparison of the sails, must be very great: For the impulse of water is many hundred times greater than that of the wind; and the arm qG of the lever, by which it acts, is incomparably greater than that by which any of the impulsions on the sails produces its effect; accordingly the ship yields much more rapidly to its action than she does to the lateral impulse of a sail.

Observe here, that if G were a fixed or supported axis, it would be the same thing whether the absolute force Dd of the rudder acts in the direction Dd, or its transverse part De acts in the direction De, both would produce the same rotation; but it is not so in a free body. The force Dd both tends to retard the ship's motion and to produce a rotation: It retards it as much as if the same force Dd had been immediately applied to the centre. And thus the real motion of the ship is compounded of a motion of the centre in a direction parallel to Dd, and of a motion round the centre. These two constitute the motion round S.

57 Employed as an example of the motions of conversion.

As the effects of the action of the rudder are both more remarkable and somewhat more simple than those of the sails, we shall employ them as an example of the mechanism of the motions of conversion in general; and as we must content ourselves in a work like this with what is very general, we shall simplify the investigation by attending only to the motion of conversion. We can get an accurate notion of the whole motion, if wanted for any purpose, by combining the progressive or retrograde motion parallel to Dd with the motion of rotation which we are about to determine.

In this case, then, we observe, in the first place, that the angular velocity (see ROTATION, N° 22.) is $\frac{Dh \cdot qG}{\int p r^2}$;

and, as was shown in that article, this velocity of rotation increases in the proportion of the time of the forces uniform action, and the rotation would be uniformly accelerated if the forces did really act uniformly. This, however, cannot be the case, because, by the ship's change of position and change of progressive velocity, the direction and intensity of the impelling force is continually changing. But if two ships are performing similar evolutions, it is obvious that the changes of force are similar in similar parts of the evolution. Therefore the consideration of the momentary evolution is sufficient for enabling us to compare the motions of ships actuated by similar forces, which is all we have in view at present. The velocity v, generated in any time t by the continuance of an invariable momentary acceleration (which is all that we mean by saying that it is produced by the action of a constant accelerating force), is as the acceleration and the time jointly. Now what we call the *angular velocity* is nothing but this momentary acceleration. Therefore the velocity v generated in the time t is $= \frac{F \cdot qG}{\int p r^2} t$.

58 Angular velocity.

The expression of the angular velocity is also the expression of the velocity v of a point situated at the distance 1 from the axis G.

Let z be the space or arch of revolution described in the time t by this point, whose distance from G is $= 1$. Then $\dot{z} = v\dot{t} = \frac{F \cdot qG}{\int p r^2} t\dot{t}$, and taking the fluent $z = \frac{F \cdot qG}{\int p r^2} t^2$. This arch measures the whole angle of rotation accomplished in the time t. These are therefore as the squares of the times from the beginning of the rotation.

Those evolutions are equal which are measured by equal arches. Thus two motions of 45 degrees each are equal. Therefore because z is the same in both, the quantity $\frac{F \cdot qG}{\int p r} t^2$ is a constant quantity, and t^2 is reciprocally proportional to $\frac{F \cdot qG}{\int p r^2}$, or is proportional to $\frac{\int p r^2}{F \cdot qG}$, and t is proportional to $\frac{\sqrt{\int p r^2}}{\sqrt{F \cdot qG}}$. That is to say, the times of the similar evolutions of two ships are as the square root of the momentum of inertia directly, and as the square root of the momentum of the rudder or sail inversely. This will enable us to make the comparison easily. Let us suppose the ships perfectly similar in form and rigging, and to differ only in length L and l; $\int P \cdot R^2$ is to $\int p r^2$ as L^5 to l^5. For the similar particles P and p contain quantities of matter which are as the cubes of their lineal dimensions, that is, as L^3 to l^3. And because the particles are similarly situated, R^2 is to r^2 as L^2 to l^2. Therefore $P \cdot R^2 : p \cdot r^2 = L^5 : l^5$. Now F is to f as L^2 to l^2. For the surfaces of the similar rudders or sails are as the squares of their lineal dimensions, that is, as L^2 to l^2. And, lastly, Gq is to gq as L to l, and therefore $F \cdot Gq : f \cdot gq = L^3 : l^3$. Therefore we have $T^2 : t^2 = \frac{\int P \cdot R^2}{F \cdot Gq} : \frac{\int p \cdot r^2}{f \cdot gq} = \frac{L^5}{L^3} : \frac{l^5}{l^3} = L^2 : l^2$, and $T : t = L : l$.

59 Times of similar evolutions with similar ships.

Therefore the times of performing similar evolutions with similar ships are proportional to the lengths of the ships when both are sailing equally fast; and since the evolutions are similar, and the forces vary similarly in their

their different parts, what is here demonftrated of the fmalleft incipient evolutions is true of the whole. They therefore not only defcribe equal angles of revolution, but alfo fimilar curves.

A fmall fhip, therefore, works in lefs time and in lefs room than a great fhip, and this in the proportion of its length. This is a great advantage in all cafes, particularly in wearing, in order to fail on the other tack clofe-hauled. In this cafe fhe will always be to windward and a-head of the large fhip, when both are got on the other tack. It would appear at firft fight that the large fhip will have the advantage in tacking. Indeed the large fhip is farther to windward when again trimmed on the other tack than the fmall fhip when fhe is juft trimmed on the other tack. But this happened before the large fhip had completed her evolution, and the fmall fhip, in the mean time, has been going forward on the other tack, and going to windward. She will therefore be before the large fhip's beam, and perhaps as far to windward.

We have feen that the velocity of rotation is proportional, *cæteris paribus*, to $F \times G q$. F means the abfolute impulfe on the rudder or fail, and is always perpendicular to its furface. This abfolute impulfe on a fail depends on the obliquity of the wind to its furface. The ufual theory fays, that it is as the fquare of the fine of incidence : but we find this not true. We muft content ourfelves with expreffing it by fome as yet unknown function ϕ of the angle of incidence a, and call it $\phi\, a$; and if S be the furface of the fail, and V the velocity of the wind, the abfolute impulfe is $n\, V^2\, S \times \phi\, a$. This acts (in the cafe of the mizen-topfail, fig. 10.) by the lever $q\, G$, which is equal to $DG \times \text{cof.}\, DG\, q$, and $DG\, q$ is equal to the angle of the yard and keel; which angle we formerly called b. Therefore its energy in producing a rotation is $n\, V^2\, S \times \phi\, a \times DG \times \text{cof.}\, b$. Leaving out the conftant quantities n, V^2, S, and DG, its energy is proportional to $\phi\, a \times \text{cof.}\, b$. In order, therefore, that any fail may have the greateft power to produce a rotation round G, it muft be fo trimmed that $\phi\, a \times \text{cof.}\, b$ may be a maximum. Thus, if we would trim the fails on the foremaft, fo as to pay the fhip off from the wind right a-head with the greateft effect, and if we take the experiments of the French academicians as proper meafures of the oblique impulfes of the wind on the fail, we will brace up the yard to an angle of 48 degrees with the keel. The impulfe correfponding to 48 is 615, and the cofine of 48° is 669. Thefe give a product of 411435. If we brace the fail to 54.44, the angle affigned by the theory, the effective impulfe is 405274. If we make the angle 45°, the impulfe is 408774. It appears then that 48° is preferable to either of the others. But the difference is inconfiderable, as in all cafes of maximum a fmall deviation from the beft pofition is not very detrimental. But the difference between the theory and this experimental meafure will be very great when the impulfes of the wind are of neceffity very oblique. Thus, in tacking fhip, as foon as the headfails are taken aback, they ferve to aid the evolution, as is evident : But if we were now to adopt the maxim inculcated by the theory, we fhould immediately round in the weather-braces, fo as to increafe the impulfe on the fail, becaufe it is then very fmall ; and although we by this means make yard more fquare, and therefore diminifh the rotatory momentum of this impulfe, yet the impulfe is more increafed (by the theory) than its vertical lever is diminifhed.— 60
Let us examine this a little more particularly, becaufe A nice point
it is reckoned one of the niceft points of feamanfhip to of feaman-
aid the fhip's coming round by means of the headfails; fhip.
and experienced feamen differ in their practice in this manœuvre. Suppofe the yard braced up to 40°, which is as much as can be ufually done, and that the fail fhivers (the bowlines are ufually let go when the helm is put down), the fail immediately takes aback, and in a moment we may fuppofe an incidence of 6 degrees. The impulfe correfponding to this is 400 (by experiment), and the cofine of 40° is 766. This gives 306400 for the effective impulfe. To proceed according to the theory, we fhould brace the yard to 70°, which would give the wind (now 34° on the weather-bow) an incidence of nearly 36°, and the fail an inclination of 20° to the intended motion, which is perpendicular to the keel. For the tangent of 20° is about $\frac{1}{2}$ of the tangent of 36°. Let us now fee what effective impulfe the experimental law of oblique impulfions will give for this adjuftment of the fails. The experimental impulfe for 36° is 480; the cofine of 70° is 342; the product is 164160, not much exceeding the half of the former. Nay, the impulfe for 36°, calculated by the theory, would have been only 346, and the effective impulfe only 118332. And it muft be farther obferved, that this theoretical adjuftment would tend greatly to check the evolution, and in moft cafes would entirely mar it, by checking the fhip's motion a-head, and confequently the action of the rudder, which is the moft powerful agent in the evolution ; for here would be a great impulfe directed almoft aftern.

We were juftifiable, therefore, in faying, in the beginning of this article, that a feaman would frequently find himfelf baffled if he were to work a fhip according to the rules deduced from M. Bouguer's work ; and we fee by this inftance of what importance it is to have the oblique impulfions of fluids afcertained experimentally. The practice of the moft experienced feaman is directly the oppofite to this theoretical maxim, and its fuccefs greatly confirms the ufefulnefs of thefe experiments of the academicians fo often praifed by us.

We return again to the general confideration of the rotatory motion. We found the velocity $v = \frac{F \cdot q\, G}{\int \rho\, r^2}$.

It is therefore proportional, *cæteris paribus*, to $q\, G$. We have feen in what manner $q\, G$ depends on the pofition and fituation of the fail or rudder when the point G is fixed. But it alfo depends on the pofition of G. With refpect to the action of the rudder, it is evident that it is fo much the more powerful as it is more remote from G. The diftance from G may be increafed either by moving the rudder farther aft or G farther forward. And as it is of the utmoft importance that a fhip anfwer her helm with the greateft promptitude, thofe circumftances have been attended to which diftinguifhed fine fteering fhips from fuch as had not this quality ; and it is in a great meafure to be afcribed to this, that, in the gradual improvement of naval architecture, the centre of gravity has been placed far forward. Perhaps the notion of a centre of gravity did not come into the thoughts of the rude builders in early times; but they obferved that thofe boats and fhips fteered beft which had

had their extreme breadth before the middle point, and conſequently the bows not ſo acute as the ſtern. This is ſo contrary to what one would expect, that it attracted attention more forcibly; and, being ſomewhat myſterious, it might prompt to attempts of improvement, by exceeding in this ſingular maxim. We believe that it has been carried as far as is compatible with other eſſential requiſites in a ſhip.

61 Of importance to determine the beſt place for a ſhip's centre of gravity.

We believe that this is the chief circumſtance in what is called the trim of a ſhip; and it were greatly to be wiſhed that the beſt place for the centre of gravity could be accurately aſcertained. A practice prevails, which is the oppoſite of what we are now advancing. It is uſual to load a ſhip ſo that her keel is not horizontal, but lower abaft. This is found to improve her ſteerage. The reaſon of this is obvious. It increaſes the acting ſurface of the rudder, and allows the water to come at it with much greater freedom and regularity; and it generally diminiſhes the griping of the ſhip forward, by removing a part of the bows out of the water. It has not always this effect; for the form of the harping aloft is frequently ſuch, that the tendency to gripe is diminiſhed by immerſing more of the bow in the water.

But waving theſe circumſtances, and attending only to the rotatory energy of the rudder, we ſee that it is of advantage to carry the centre of gravity forward. The ſame advantage is gained to the action of the after ſails. But, on the other hand, the action of the headſails is diminiſhed by it; and we may call every ſail a headſail whoſe centre of gravity is before the centre of gravity of the ſhip; that is, all the ſails hoiſted on the bowſprit and foremaſt, and the ſtayſails hoiſted on the mainmaſt; for the centre of gravity is ſeldom far before the mainmaſt.

Suppoſe that when the rudder is put into the poſition AD (fig. 11.), the centre of gravity could be ſhifted to g, ſo as to increaſe q G, and that this is done without increaſing the ſum of the products $p\,r^2$. It is obvious that the velocity of converſion will be increaſed in the proportion of q G to $q\,g$. This is very poſſible, by bringing to that ſide of the ſhip parts of her loading which were ſituated at a diſtance from G on the other ſide. Nay, we can make this change in ſuch a manner that $\int p\,r^2$ ſhall even be leſs than it was before, by taking care that every thing which we ſhift ſhall be nearer to g than it was formerly to G. Suppoſe it all placed in one ſpot m, and that m is the quantity of matter ſo ſhifted, while M is the quantity of matter in the whole ſhip. It is only neceſſary that $m \cdot g\,\mathrm{G}^2$ ſhall be leſs than the ſum of the products $p\,r^2$ correſponding to the matter which has been ſhifted. Now, although the matter which is eaſily moveable is generally very ſmall in compariſon to the whole matter of the ſhip, and therefore can make but a ſmall change in the place of the centre of gravity, it may frequently be brought from places ſo remote that it may occaſion a very ſenſible diminution of the quantity $\int p\,r^2$, which expreſſes the whole momentum of inertia.

62 A practice of ſeamen in putting about explained.

This explains a practice of the ſeamen in ſmall wherries or ſkiffs, who in putting about are accuſtomed to place themſelves to leeward of the maſt. They even find that they can aid the quick motions of theſe light boats by the way in which they reſt on their two feet, ſometimes leaning all on one foot, and ſometimes on the other. And we have often ſeen this evolution very ſenſibly accelerated in a ſhip of war, by the crew running ſuddenly, as the helm is put down, to the lee-bow. And we have heard it aſſerted by very expert ſeamen, that after all attempts to wear ſhip (after lying-to in a ſtorm) have failed, they have ſucceeded by the crew collecting themſelves near the weather fore-ſhrouds the moment the helm was put down. It muſt be agreeable to the reflecting ſeaman to ſee this practice ſupported by undoubted mechanical principles.

It will appear paradoxical to ſay that the evolution may be accelerated even by an addition of matter to the ſhip; and though it is only a piece of curioſity, our readers may wiſh to be made ſenſible of it. Let m be the addition, placed in ſome point m lying beyond G from q. Let S be the ſpontaneous centre of converſion before the addition. Let v be the velocity of rotation round g, that is, the velocity of a point whoſe diſtance from g is 1, and let ϱ be the radius vector, or diſtance of a particle from g. We have (ROTATION, N° 22.) $v = \dfrac{\mathrm{F} \cdot q\,g}{\int p\,\varrho^2 + m \cdot m\,g^2}$. But we know (ROTATION, N° 23.) that $\int p\,\varrho^2 = \int p\,r^2 + \mathrm{M} \cdot \mathrm{G}\,g^2$. Therefore $v = \dfrac{\mathrm{F} \cdot q\,g}{\int p\,r^2 + \mathrm{M} \cdot \mathrm{G}\,g^2 + m \cdot m\,g^2}$. Let us determine G g and $m\,g$ and $q\,g$. 63 The evolution accelerated by additional matter.

Let m G be called z. Then, by the nature of the centre of gravity, $\mathrm{M}+m : \mathrm{M} = \mathrm{G}\,m : g\,m = z : g\,m$, and $g\,m = \dfrac{\mathrm{M}}{\mathrm{M}+m}\,z$, and $m \cdot g\,m^2 = \dfrac{m\,\mathrm{M}^2}{\overline{\mathrm{M}+m}^2}\,z^2$. In like manner, $\mathrm{M} \cdot \mathrm{G}\,g^2 = \dfrac{\mathrm{M}\,m^2}{\overline{\mathrm{M}+m}^2}\,z^2$. Now $m\,\mathrm{M}^2 + \mathrm{M}\,m^2 = \mathrm{M}\,m \times \overline{\mathrm{M}+m}$. Therefore $\mathrm{M} \cdot \mathrm{G}\,g^2 + m \cdot g\,m^2 = \dfrac{\mathrm{M}\,m \times (\mathrm{M}+m)}{\overline{\mathrm{M}+m}^2}\,z^2, = \dfrac{\mathrm{M}\,m}{\mathrm{M}+m}\,z^2$. Let n be $= \dfrac{m}{\mathrm{M}+m}$, then $\mathrm{M} \cdot \mathrm{G}^2 + m \cdot g\,m^2 = \mathrm{M}\,n\,z^2$. Alſo G $g = n\,z$, being $= \dfrac{m}{\mathrm{M}+n}\,z$. Let q G be called c: then $q\,g = c + n\,z$. Alſo let SG be called e.

We have now for the expreſſion of the velocity $v = \dfrac{\mathrm{F}\,(c+n\,z)}{\int p\,r^2 + \mathrm{M}\,n\,z^2}$, or $v = \dfrac{\mathrm{F}}{\mathrm{M}} \times \dfrac{c+n\,z}{\dfrac{\int p\,r^2}{\mathrm{M}} + n\,z^2}$. But (ROTATION, N° 30) $\dfrac{\int p\,r^2}{\mathrm{M}} = c\,e$. Therefore, finally, $v = \dfrac{\mathrm{F}}{\mathrm{M}} \times \dfrac{c+n\,z}{c\,e+n\,z^2}$. Had there been no addition of matter made, we ſhould have had $v = \dfrac{\mathrm{F}}{\mathrm{M}} \times \dfrac{c}{c\,e}$. It remains to ſhow, that z may be ſo taken that $\dfrac{c}{c\,e}$ may be leſs than $\dfrac{c+n\,z}{c\,e+n\,z^2}$. Now, if c be to z as $c\,e$ to z^2, that is, if z

be

be taken equal to e, the two fractions will be equal. But if z be less than e, that is, if the additional matter is placed anywhere between S and G, the complex fraction will be greater than the fraction $\frac{c}{ce}$, and the velocity of rotation will be increased. There is a particular distance which will make it the greatest possible, namely, when z is made $=\frac{1}{n}(\sqrt{c^2+nce}-c)$, as will easily be found by treating the fraction $\frac{c+nz}{ce+nz^2}$, with z, considered as the variable quantity, for a maximum. In what we have been saying on this subject, we have considered the rotation only in as much as it is performed round the centre of gravity, although in every moment it is really performed round a spontaneous axis lying beyond that centre. This was done because it afforded an easy investigation, and any angular motion round the centre of gravity is equal to the angular motion round any other point. Therefore the extent and the time of the evolution are accurately defined.—

64 The rotation performed round a spontaneous axis.

From observing that the energy of the force F is proportional to qG, an inattentive reader will be apt to conceive the centre of gravity as the centre of motion, and the rotation as taking place, because the momenta of the sails and rudder, on the opposite sides of the centre of gravity, do not balance each other. But we must always keep in mind that this is not the cause of the rotation. The cause is the want of equilibrium round the point C (fig. 10.), where the actions of the water balance each other. During the evolution, which consists of a rotation combined with a progressive motion, this point C is continually shifting, and the unbalanced momenta which continue the rotation always respect the momentary situation of the point C. It is nevertheless always true that the energy of a force F is proportional (*cæteris paribus*) to qG, and the rotation is always made in the same direction as if the point G were really the centre of conversion. Therefore the mainsail acts always (when oblique) by pushing the stern away from the wind, although it should sometimes act on a point of the vertical lever through C, which is a-head of C.

These observations on the effects of the sails and rudder in producing a conversion, are sufficient for enabling us to explain any case of their action which may occur. We have not considered the effects which they tend to produce by inclining the ship round a horizontal axis, viz. the motions of rolling and pitching. See ROLLING and PITCHING. To treat this subject properly would lead us into the whole doctrine of the equilibrium of floating bodies, and it would rather lead to maxims of construction than to maxims of manœuvre. M. Bouguer's *Traité du Navire* and Euler's *Scientia Navalis* are excellent performances on this subject, and we are not here obliged to have recourse to any erroneous theory.

65 Different operations of the water on the ship and wind on the sails balance each other.

It is easy to see that the lateral pressure both of the wind on the sails and of the water on the rudder tends to incline the ship to one side. The sails also tend to press the ship's bows into the water, and, if she were kept from advancing, would press them down considerably. But by the ship's motion, and the prominent form of her bows, the resistance of the water to the fore part of the ship produces a force which is directed upwards. The sails also have a small tendency to raise the ship, for they constitute a surface which in general separates from the plumb-line below. This is remarkably the case in the staysails, particularly the jib and fore-topmast staysail. And this helps greatly to soften the plunges of the ship's bows into the head seas. The upward pressure also of the water on her bows, which we just now mentioned, has a great effect in opposing the immersion of the bows which the sails produce by acting on the long levers furnished by the masts. M. Bouguer gives the name of *point velique* to the point V (fig. 12.) of the mast, where it is cut by the line CV, which marks the mean place and direction of the whole impulse of the water on the bows. And he observes, that if the mean direction of all the actions of the wind on the sails be made to pass also through this point, there will be a perfect equilibrium, and the ship will have no tendency to plunge into the water or to rise out of it; for the whole action of the water on the bows, in the direction CV, is equivalent to, and may be resolved into the action CE, by which the progressive motion is resisted, and the vertical action CD, by which the ship is raised above the water. The force CE must be opposed by an equal force VD, exerted by the wind on the sails, and the force CD is opposed by the weight of the ship. If the mean effort of the sails passes above the point V, the ship's bow will be pressed into the water; and if it pass below V, her stern will be pressed down. But, by the union of these forces, she will rise and fall with the sea, keeping always in a parallel position. We apprehend that it is of very little moment to attend to the situation of this point. Except when the ship is right afore the wind, it is a thousand chances to one that the line CV of mean resistance does not pass through any mast; and the fact is, that the ship cannot be in a state of uniform motion on any other condition but the perfect union of the line of mean action of the sails, and the line of mean action of the resistance. But its place shifts by every change of leeway or of trim; and it is impossible to keep these lines in one constant point of intersection for a moment, on account of the incessant changes of the surface of the water on which she floats. M. Bouguer's observations on this point are, however, very ingenious and original.

Fig. 12.

66 Chief evolutions described.

We conclude this dissertation, by describing some of the chief movements or evolutions. What we have said hitherto is intended for the instruction of the artist, by making him sensible of the mechanical procedure. The description is rather meant for the amusement of the landsman, enabling him to understand operations that are familiar to the seaman. The latter will perhaps smile at the aukward account given of his business by one who cannot hand, reef, or steer.

To tack Ship.

THE ship must first be kept full, that is, with a very sensible angle of incidence on the sails, and by no means hugging the wind. For as this evolution is chiefly performed by the rudder, it is necessary to give the ship a good velocity. When the ship is observed to luff up of herself, that moment is to be catched for beginning the evolution, because she will by her inherent force continue this motion. The helm is then put down. When the officer calls out Helm's a-lee, the fore-sheet, fore-top bowline, jib, and stay sail sheets forward

ward are let go. The jib is frequently hauled down. Thus the obftacles to the fhip's head coming up to the wind by the action of the rudder are removed. If the mainfail is fet, it is not unufual to clue up the weather fide, which may be confidered as a headfail, becaufe it is before the centre of gravity. The mizen muft be hauled out, and even the fail braced to windward. Its power in paying off the ftern from the wind confpires with the action of the rudder. It is really an aerial rudder. The fails are immediately taken aback. In this ftate the effect of the mizen-topfail would be to obftruct the movement, by preffing the ftern the contrary way to what it did before. It is therefore either immediately braced about fharp on the other tack, or lowered. Bracing it about evidently tends to pay round the ftern from the wind, and thus affift in bringing the head up to the wind. But in this pofition it checks the progreffive motion of the fhip, on which the evolution chiefly depends. For a rapid evolution, therefore, it is as well to lower the mizen-topfail. Meantime, the headfails are all aback, and the action of the wind on them tends greatly to pay the fhip round. To increafe this effect, it is not unufual to haul the fore-top bowline again. The fails on the mainmaft are now almoft becalmed; and therefore when the wind is right ahead, or a little before, the mainfail is hauled round and braced up fharp on the other tack with all expedition. The ftayfail fheets are now fhifted over to their places for the other tack. The fhip is now entirely under the power of the headfails and of the rudder, and their actions confpire to promote the converfion. The fhip has acquired an angular motion, and will preferve it, fo that now the evolution is fecured, and fhe falls off apace from the wind on the other tack. The farther action of the rudder is therefore unneceffary, and would even be prejudicial, by caufing the fhip to fall off too much from the wind before the fails can be fhifted and trimmed for failing on the other tack. It is therefore proper to right the helm when the wind is right ahead, that is, to bring the rudder into the direction of the keel. The fhip continues her converfion by her inherent force and the action of the headfails.

When the fhip has fallen off about four points from the wind, the headfails are hauled round, and trimmed fharp on the other tack with all expedition; and although this operation was begun with the wind four points on the bow, it will be fix before the fails are braced up, and therefore the headfails will immediately fill. The after-fails have filled already, while the headfails were inactive, and therefore immediately check the farther falling off from the wind. All fails now draw, for the ftayfail fheets have been fhifted over while they were becalmed or fhaking in the wind. The fhip now gathers way, and will obey the fmalleft motion of the helm to bring her clofe to the wind.

We have here fuppofed, that during all this operation the fhip preferves her progreffive motion. She muft therefore have defcribed a curve line, advancing all the while to windward. Fig. 13. is a reprefentation of this evolution when it is performed in the completeft manner. The fhip ftanding on the courfe E *a*, with the wind blowing in the direction WF, has her helm put hard a-lee when fhe is in the pofition A. She immediately deviates from her courfe, and defcribing a curve, comes to the pofition B, with the wind blowing in the direction WF of the yards, and the fquare-fails now fhiver. The mizen topfail is here reprefented braced fharp on the other tack, by which its tendency to aid the angular motion (while it checks the progreffive motion) is diftinctly feen. The main and forefails are now fhivering, and immediately after are taken aback. The effect of this on the headfails is diftinctly feen to be favourable to the converfion, by pufhing the point F in the direction F *i*; but for the fame reafon it continues to retard the progreffive motion. When the fhip has attained to the pofition C, the mainfail is hauled round and trimmed for the other tack. The impulfe in the direction *Fi* ftill aids the converfion and retards the progreffive motion. When the fhip has attained a pofition between C and D, fuch that the main and mizen topfail yards are in the direction of the wind, there is nothing to counteract the force of the headfails to pay the fhip's head off from the wind. Nay, during the progrefs of the fhip to this intermediate pofition, if any wind gets at the main or mizen topfails, it acts on their anterior furfaces, and impels the after parts of the fhip away from the curve *a b c d*, and thus aids the revolution. We have therefore faid, that when once the fails are taken fully aback, and particularly when the wind is brought right ahead, it is fcarce poffible for the evolution to fail; as foon therefore as the main topfail (trimmed for the other tack) fhivers, we are certain that the headfails will be filled by the time they are hauled round and trimmed. The ftayfails are filled before this, becaufe their fheets have been fhifted, and they ftand much fharper than the fquare-fails; and thus every thing tends to check the falling off from the wind on the other tack, and this no fooner than it fhould be done. The fhip immediately gathers way, and holds on in her new courfe *d* G.

Fig. 13.

But it frequently happens, that in this converfion the fhip lofes her whole progreffive motion. This fometimes happens while the fails are fhivering before they are taken fully aback. It is evident, that in this cafe there is little hopes of fuccefs, for the fhip now lies like a log, and neither fails nor rudder have any action. The fhip drives to leeward like a log, and the water acting on the lee-fide of the rudder checks a little the driving of the ftern. The head therefore falls off again, and by and by the fails fill, and the fhip continues on her former tack. This is called MISSING STAYS, and it is generally owing to the fhip's having too little velocity at the beginning of the evolution. Hence the propriety of keeping the fails well filled for fome little time before. Rough weather, too, by raifing a wave which beats violently on the weather-bow, frequently checks the firft luffing of the fhip, and beats her off again.

If the fhip lofe all her motion after the headfails have been fully taken aback, and before we have brought the wind right ahead, the evolution becomes uncertain, but by no means defperate; for the action of the wind on the headfails will prefently give her fternway. Suppofe this to happen when the fhip is in the pofition C. Bring the helm over hard to windward, fo that the rudder fhall have the pofition reprefented by the fmall dotted line *e f*. It is evident, that the refiftance of the water to the ftern-way of the rudder acts in a favourable direction, pufhing the ftern outwards. In the mean time, the action of the wind on the headfails pufhes the head in the oppofite direction. Thefe actions

tions conſpire therefore in promoting the evolution; and if the wind is right ahead, it cannot fail, but may even be completed ſpeedily, becauſe the ſhip gathers ſternway, and the action of the rudder becomes very powerful; and as ſoon as the wind comes on the formerly lee-bow, the action of the water on the now lee-quarter will greatly accelerate the converſion. When the wind therefore has once been brought nearly right ahead, there is no riſk of being baffled.

But ſhould the ſhip have loſt all her headway conſiderably before this, the evolution is very uncertain: for the action of the water on the rudder may not be nearly equal to its contrary action on the lee-quarter; in which caſe, the action of the wind on the headſails may not be ſufficient to make up the difference. When this is obſerved, when the ſhip goes aſtern without changing her poſition, we muſt immediately throw the headſails completely aback, and put the helm down again, which will pay off the ſhip's head from the wind enough to enable us to fill the ſails again on the ſame tack, to try our fortune again; or we muſt BOXHAUL the ſhip, in the manner to be deſcribed by and by.

Such is the ordinary proceſs of tacking ſhip; a proceſs in which all the different modes of action of the rudder and ſails are employed. To execute this evolution in the moſt expeditious manner, and ſo as to gain as much on the wind as poſſible, is conſidered as the teſt of an expert ſeaman. We have deſcribed the proceſs which is beſt calculated for *enſuring* the movement. But if the ſhip be ſailing very briſkly in ſmooth water, ſo that there is no danger of miſſing ſtays, we may gain more to windward conſiderably by keeping faſt the fore-top bowline and the jib and ſtay-ſail ſheets till the ſquare-ſails are all ſhivering: For theſe ſails, continuing to draw with conſiderable force, and balancing each other tolerably fore and aft, keep up the ſhip's velocity very much, and thus maintain the power of the rudder. If we now let all fly when the ſquare ſails are ſhivering, the ſhip may be conſidered as without ſails, but expoſed to the action of the water on the lee-bow; from which ariſes a ſtrong preſſure of the bow to windward, which conſpires with the action of the rudder to aid the converſion. It evidently leaves all that tendency of the bow to windward which ariſes from leeway, and even what was counteracted by the formerly unbalanced action of theſe head-ſtayſails. This method lengthens the whole time of the evolution, but it advances the ſhip to windward. Obſerve, too, that keeping faſt the fore-top bowline till the ſail ſhivers, and then letting it go, inſures the taking aback of that ſail, and thus inſtantly produces an action that is favourable to the evolution.

The moſt expert ſeamen, however, differ among themſelves with reſpect to theſe two methods, and the firſt is the moſt generally practiſed in the Britiſh navy, becauſe the leaſt liable to fail. The forces which oppoſe the converſion are ſooner removed, and the production of a favourable action by the backing of the fore-top-ſail is alſo ſooner obtained, by letting go the fore-top bowline at the firſt.

Having entered ſo minutely into the deſcription and rationale of this evolution, we have ſufficiently turned the reader's attention to the different actions which cooperate in producing the motions of converſion. We ſhall therefore be very brief in our deſcription of the other evolutions.

To wear Ship.

WHEN the ſeaman ſees that his ſhip will not go about head to wind, but will miſs ſtays, he muſt change his tack the other way; that is, by turning her head away from the wind, going a little way before the wind, and then hauling the wind on the other tack. This is called WEARING or VEERING ſhip. It is moſt neceſſary in ſtormy weather with little ſail, or in very faint breezes, or in a diſabled ſhip.

The proceſs is exceedingly ſimple; and the mere narration of the procedure is ſufficient for ſhowing the propriety of every part of it.

Watch for the moment of the ſhip's falling off, and then haul up the mainſail and mizen, and ſhiver the mizen topſail, and put the helm a-weather. When the ſhip falls off ſenſibly (and not before), let go the bowlines. Eaſe away the fore-ſheet, raiſe the fore-tack, and gather aft the weather fore-ſheet, as the lee-ſheet is eaſed away. Round in the weather-braces of the fore and main-maſts, and keep the yards nearly biſecting the angle of the wind and keel, ſo that when the ſhip is before the wind the yards may be ſquare. It may even be of advantage to round in the weather-braces of the main-topſail more than thoſe of the head-ſails; for the mainmaſt is abaft the centre of gravity. All this while the mizen-topſail muſt be kept ſhivering, by rounding in the weather-braces as the ſhip pays off from the wind. Then the main top-ſail will be braced up for the other tack by the time that we have brought the wind on the weather-quarter. After this it will be full, and will aid the evolution. When the wind is right aft, ſhift the jib and ſtay-ſail ſheets. The evolution now goes on with great rapidity; therefore briſkly haul on board the fore and main tacks, and haul out the mizen, and ſet the mizen-ſtayſail as ſoon as they will take the wind the right way. We muſt now check the great rapidity with which the ſhip comes to the wind on the other tack, by righting the helm before we bring the wind on the beam; and all muſt be trimmed ſharp fore and aft by this time, that the headſails may take and check the coming-to. All being trimmed, ſtand on cloſe by the wind.

We cannot help loſing much ground in this movement. Therefore, though it be very ſimple, it requires much attention and rapid execution to do it with as little loſs of ground as poſſible. One is apt to imagine at firſt that it would be better to keep the headſails braced up on the former tack, or at leaſt not to round in the weather-braces ſo much as is here directed. When the ſhip is right afore the wind, we ſhould expect aſſiſtance from the obliquity of the head-ſails; but the the rudder being the principal agent in the evolution, it is found that more is gained by increaſing the ſhip's velocity, than by a ſmaller impulſe in the headſails more favourably directed. Experienced ſeamen differ, however, in their practice in reſpect of this particular.

To box-haul a Ship.

THIS is a proceſs performed only in critical ſituations, as when a rock, a ſhip, or ſome danger, is ſuddenly ſeen right ahead, or when a ſhip miſſes ſtays. It requires the moſt rapid execution.

The ſhip being cloſe-hauled on a wind, haul up the mainſail

mainſail and mizen, and ſhiver the top-ſails, and put the helm hard a-lee altogether. Raiſe the fore-tack, let go the head bowlines, and brace about the headſails ſharp on the other tack. The ſhip will quickly loſe her way, get ſtern-way, and then fall off, by the joint action of the headſails and of the inverted rudder. When ſhe has fallen off eight points, brace the after-ſails ſquare, which have hitherto been kept ſhivering. This will at firſt increaſe the power of the rudder, by increaſing the ſtern-way, and at the ſame time it makes no oppoſition to the converſion which is going on. The continuation of her circular motion will preſently cauſe them to take the wind on their after ſurfaces. This will check the ſtern-way, ſtop it, and give the ſhip a little head-way. Now ſhift the helm, ſo that the rudder may again act in conjunction with the headſails in paying her off from the wind. This is the critical part of the evolution, becauſe the ſhip has little or no way through the water, and will frequently remain long in this poſition. But as there are no counteracting forces, the ſhip continues to fall off. Then the weather-braces of the after-ſails may be gently rounded in, ſo that the wind acting on their hinder ſurfaces may both puſh the ſhip a little ahead and her ſtern laterally in conjunction with the rudder. Thus the wind is brought upon the quarter, and the headſails ſhiver. By this time the ſhip has acquired ſome headway. A continuation of the rotation would now fill the headſails, and their action would be contrary to the intended evolution. They are therefore immediately braced the other way, nearly ſquare, and the evolution is now completed in the ſame manner with wearing ſhip.

Some ſeamen brace all the ſails aback the moment that the helm is put hard a-lee, but the after-ſails no more aback than juſt to ſquare the yards. This quickly gives the ſhip ſtern-way, and brings the rudder into action in its inverted direction; and they think that the evolution is accelerated by this method.

There is another problem of ſeamanſhip deſerving of our attention, which cannot properly be called an evolution. This is lying-to. This is done in general by laying ſome ſails aback, ſo as to ſtop the head-way produced by others. But there is a conſiderable addreſs neceſſary for doing this in ſuch a way that the ſhip ſhall lie eaſily, and under command, ready to proceed in her courſe, and eaſily brought under weigh.

To bring-to with the fore or main topſail to the maſt, brace that ſail ſharp aback, haul out the mizen, and clap the helm hard a-lee.

Suppoſe the fore topſail to be aback; the other ſails ſhoot the ſhip ahead, and the lee-helm makes the ſhip come up to the wind, which makes it come more perpendicularly on the ſail which is aback. Then its impulſe ſoon exceeds thoſe on the other ſails, which are now ſhivering, or almoſt ſhivering. The ſhip ſtands ſtill awhile, and then falls off, ſo as to fill the after ſails, which again ſhoot her ahead, and the proceſs is thus repeated. A ſhip lying to in this way goes a good deal ahead and alſo to leeward. If the main topſail be aback, the ſhip ſhoots ahead, and comes up till the diminiſhed impulſe of the drawing ſails in the direction of the keel is balanced by the increaſed impulſe on the main-topſail. She lies a long while in this poſition, driving ſlowly to leeward; and ſhe at laſt falls off by the beating of the water on her weather-bow. She falls off but little, and ſoon comes up again.

Thus a ſhip lying-to is not like a mere log, but has a certain motion which keeps her under command. To get under weigh again, we muſt watch the time of falling off; and when this is juſt about to finiſh, brace about briſkly, and fill the ſail which was aback. To aid this operation, the jib and fore-topmaſt ſtay-ſail may be hoiſted, and the mizen brailed up: or, when the intended courſe is before the wind or large, back the fore-topſail ſharp, ſhiver the main and mizen topſail, brail up the mizen, and hoiſt the jib and fore-topmaſt ſtay-ſails altogether.

In a ſtorm with a contrary wind, or on a lee ſhore, a ſhip is obliged to lie-to under a very low ſail. Some ſail is abſolutely neceſſary, in order to keep the ſhip ſteadily down, otherwiſe ſhe would kick about like a cork, and roll ſo deep as to ſtrain and work herſelf to pieces. Different ſhips behave beſt under different ſails. In a very violent gale, the three lower ſtay-ſails are in general well adapted for keeping her ſteady, and diſtributing the ſtrain. This mode ſeems alſo well adapted for wearing, which may be done by hauling down the mizen-ſtayſail. Under whatever ſail the ſhip is brought-to in a ſtorm, it is always with a fitted ſail, and never with one laid aback. The helm is laſhed down hard a-lee; therefore the ſhip ſhoots ahead, and comes up till the ſea on her weather-bow beats her off again. Getting under weigh is generally difficult; becauſe the ſhip and rigging are lofty abaft, and hinder her from falling off readily when the helm is put hard a-weather. We muſt watch the falling off, and aſſiſt the ſhip by ſome ſmall headſail. Sometimes the crew get up on the weather fore-ſhrowds in a crowd, and thus preſent a ſurface to the wind.

THESE examples of the three chief evolutions will enable thoſe who are not ſeamen to underſtand the propriety of the different ſteps, and alſo to underſtand the other evolutions as they are deſcribed by practical authors. We are not acquainted with any performance in our language where the whole are conſidered in a connected and ſyſtematic manner. There is a book on this ſubject in French, called *Le Manœuvrier*, by M. Burdé de Ville-Huet, which is in great reputation in France. A tranſlation into Engliſh was publiſhed ſome years ago, ſaid to be the performance of the Chevalier de Sauſeuil a French officer. But this appears to be a bookſeller's puff; for it is undoubtedly the work of ſome perſon who did not underſtand either the French language, or the ſubject, or the mathematical principles which are employed in the ſcientific part. The blunders are not ſuch as could poſſibly be made by a Frenchman not verſant in the Engliſh language, but natural for an Engliſhman ignorant of French. No French gentleman or officer would have tranſlated a work of this kind (which he profeſſes to think ſo highly of) to ſerve the rivals and foes of his country. But indeed it can do no great harm in this way; for the ſcientific part of it is abſolutely unintelligible for want of ſcience in the tranſlator; and the practical part is full of blunders for want of knowledge of the French language.

We offer this account of the ſubject with all proper reſpect and diffidence. We do not profeſs to teach: but

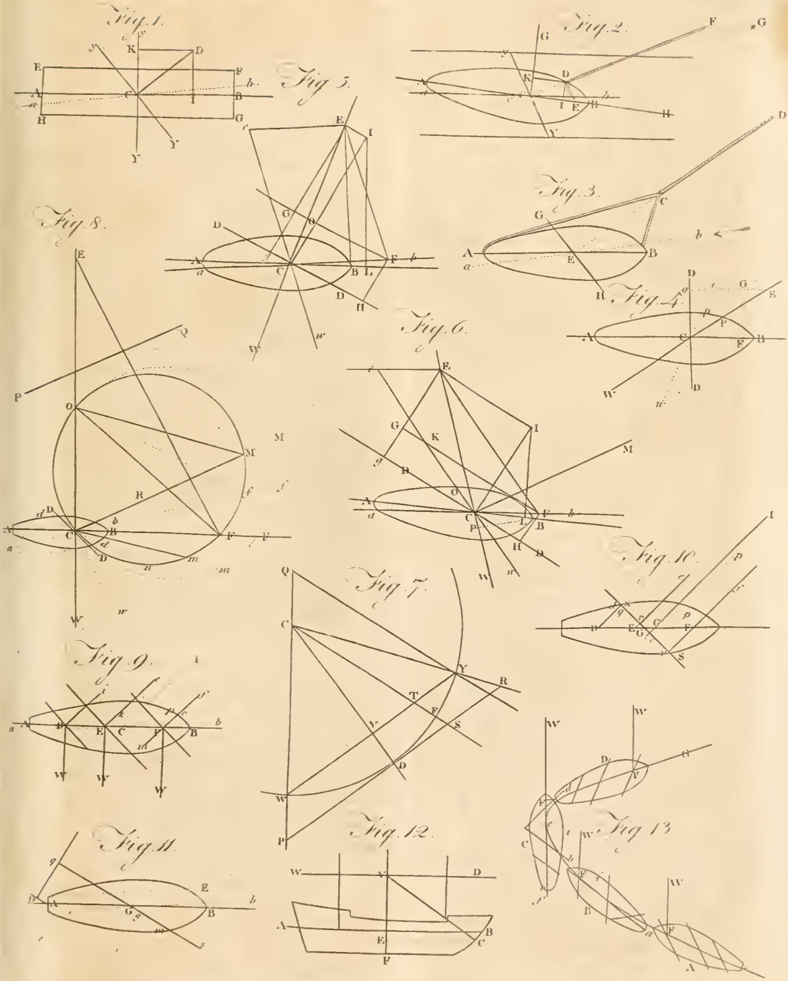


Fig. 1.
Fig. 2.
Fig. 3.
Fig. 4.
Fig. 5.
Fig. 6.
Fig. 7.
Fig. 8.
Fig. 9.
Fig. 10.
Fig. 11.
Fig. 12.
Fig. 13.

but by pointing out the defects of the celebrated works of M. Bouguer, and the courfe which may be taken to remove them, while we preserve much valuable knowledge which they contain, we may perhaps excite fome perfons to apply to this fubject, who, by a combination of what is juft in M. Bouguer's theory, with an experimental doctrine of the impulfes of fluids, may produce a treatife of feamanfhip which will not be confined to the libraries of mathematicians, but become a manual for feamen by profeffion.

SEAMEN, fuch perfons as ferve the king or others at fea by navigation and fighting fhips, &c. See *MARITIME State*.

Seamen fighting, quarrelling, or making any difturbance, may be punifhed by the commiffioners of the navy with fine and imprifonment. Regiftered feamen are exempted from ferving in any parifh office, &c. and are allowed bounty-money befide their pay. By the law of merchants, the feamen of a veffel are accountable to the mafter or commander, the mafter to the owners, and the owners to the merchants, for damage fuftained either by negligence or otherwife. Where a feamen is hired for a voyage, and he deferts before it is ended, he fhall lofe his wages; and in cafe a fhip be loft in a ftorm, the feamen lofe their wages, as well as the owners their freight.

Means of Preferving the Health of SEAMEN. See MEDICINE, N° 351.

In addition to what has been faid on this fubject in the place referred to, we fhall fubjoin fome valuable obfervations which we have met with in the fixth volume of the Memoirs of the Royal Society of Medicine at Paris for the years 1784 and 1785.

In 1783, the marfhal de Caftries, intending to make fome changes in the regulations of the navy, particularly with regard to diet, propofed to the fociety the two following queftions: 1. " What are the moft wholefome aliments for feamen, confidering the impoffibility of procuring them frefh meat? And what kinds of falt meat or fifh, of pulfe, and of drink, are moft proper for them, and in what quantity, not omitting to inquire into the regimens in ufe amongft other maritime nations for what may be adopted by us, and into what experience has evinced the utility of, from the accounts of the moft celebrated navigators?" 2. " A number of patients labouring under different difeafes being affembled in naval hofpitals, and different conftitutions affected by the fame difeafe requiring difference of diet, what general dietetic rules for an hofpital would be beft adapted to every exigence, dividing the patients into three claffes; the firft in which liquids alone are proper, the fecond in which we begin to give folids in fmall quantities, and the ftate of convalefcence in which a fuller diet is neceffary?" A committee was appointed to draw up an anfwer to thefe, who inveftigated the fubject very minutely. The refult of their labours is there given at large. The obfervations moft worthy of notice are, that the fcurvy of the Englifh feamen, who live chiefly on falt-meat, is a putrid difeafe; whilft that of the Dutch, who ufe farinaceous vegetables and dried pulfe in large quantities, has more of an hydropical tendency. A mixture of both, even at the fame meal, is recommended. This is fupported by philofophical reafoning, and the example of Captain Cook, who was partly indebted to this mixed regimen for the prefervation of his crew. Salt fifh fhould never be ufed: falt beef grows hard, and after boiling its fibrous parts only remain, which are more calculated to load the ftomach than recruit the ftrength. Salt bacon may be kept at fea 18 months; it does not lofe its moift and nutrimental parts, and unites better with pulfe, but fhould not be ufed when rancid. Live animals kept on board fhips tend to produce difeafes amongft the crew. Rice fhould be ufed largely. Our puddings are bad food: the flour would be much better made into bread, which might be done at fea with no great trouble. Sour krout fhould be ufed freely. Muftard, vinegar, fugar, melaffes, and honey, are good antifcorbutics. Of drinks, wine is the beft: wort, fpruce-beer, or the Ruffian *quas*, are good fubftitutes. Spirits are only to be ufed in cold climates, and in fmall quantity. The greater part of the excellent memoir in anfwer to the fecond queftion, perfectly coincides with M. Duhamel du Monceaux's " Means of Preferving the Health of Seamen," and M. Poiffonnier des Perrieres's treatifes " On the Difeafes of Seamen," and " On the advantages of changing the Diet of Seamen," and his " Examination of Pringle's Differtation."

SEAPOYS, or SEPOYS, natives of Indoftan ferving in a military capacity under the European powers, and difciplined after the European manner.

The Seapoys of the Englifh Eaft India company compofe perhaps the moft numerous, regular, and beft difciplined body of black troops in the world. They are raifed from among the natives of the country, and confift of Moors or Mahometans, Raja-poots, Hindoos, Pariars, befides many intermediate cafts peculiar to themfelves; the whole modelled in all correfponding particulars, and difciplined in every refpect as the army of Great Britain.

The military eftablifhments of Bengal, Madras and Bombay, have each their refpective numbers, that of Bengal exceeding the reft. The Seapoys are formed into complete, uniform, and regular battalions, as our marching regiments at home, being intended to reprefent and anfwer fully to every purpofe in India to the like troops in Europe. A battalion confifts of 700 men, of complete effective ftrength. In each there are eight companies, including two flank ones or grenadiers. They are refpectively commanded by their own black and European officers; to each company there is attached a fubaltern, who takes the command, under whom are two native commiffioned officers, bearing the rank of fubidar and jimindar; of eight fubalterns, fix are lieutenants, the other enfigns; exclufive is a ftaff, of adjutant and furgeon. The black non-commiffioned officers anfwer to our ferjeants and corporals, and are called *havildars* and *naigues*. There is alfo to each corps an Englifh ferjeant-major, drill and ftore ferjeant; to each battalion is a band of drums and fifes, and to each a pair of colours. A captain commands the whole.

Their jackets, which are made entirely after the European faſhion, are of a red colour with yellow facings (as worn by all the infantry of the company on the Coromandel coaſt). The remaining part of their attire reſembles more the country or Indian habit, and conſiſts of a dark blue turban, broad and round at top, deſcending deep to the bottom, the ſides of which, of a concave form, are croſſed by a white band, running in front, faſtened under a roſe above. As an under garment, they have a jacket of linen. A dark blue ſaſh girding, to anſwer the turban, goes round their middle. On the thighs they have ſhort drawers, faſtened by a ſcolloped band. Their legs are bare, which renders them more ready for action or ſervice. Their arms are a firelock and bayonet; their accoutrements or croſs belts black leather, with pouches the ſame.

A battalion drawn out cannot but ſtrike the ſpectators with a lively and fanciful military impreſſion, as they unite in their exterior traits reſpectively Indian and European.

They are brought to the utmoſt exactneſs of diſcipline; go through their evolutions and manœuvres with a regularity and preciſion equal to, and not ſurpaſſed by European troops. In action they are brave and ſteady, and have been known to ſtand where Europeans have given way.

Their diſcipline puts them on a footing with European troops, with whom they are always ready to act in concert.

Their utility and ſervices are evident: they ſecure to the company the internal good order and preſervation of their territorial diſtricts, which, though poſſible to be enforced with a ſtrong hand by Europeans, requires numbers, and can only be conducted with that eaſe and addreſs peculiar to the native forces of the country.

They are conſidered with reſpect in the eyes of the other natives, though they ſufficiently, and with a good grace, feel and aſſert their own conſequence. In large garriſons, where the duty is great, as Madras, Pondicherry, Trichinopoly, Vellore, &c. two or three battalions might be preſent together, excluſive of Europeans. If ſent ſingly up the country, they are liable to be detached, ſometimes by one or more companies being ſent to a ſtation dependent on the chief garriſon or headquarters, otherwiſe they are diſperſed through the diſtricts, four or five together, with a non-commiſſioned officer (this is a part of the ſervice which is called *going on command*), on hills, or in villages, to preſerve order, convey intelligence, and aſſiſt the taſildar, renter, or cutwall of the place, in caſes of emergency. They alſo enforce the police, and prevent in ſuch caſes the country from being infeſted with thieves, which otherwiſe have combined, forming a banditti, to rob paſſengers and plunder cattle, of which there are ſo many inſtances upon record. As for ſuch Britiſh officers in the company's ſervice as are attached to battalions, they are obliged to follow the fortunes and deſtinations of their men, with their reſpective corps, leading a life often replete with adventures of a peculiar nature. An individual in ſuch caſes is frequently ſecluded from thoſe of his own colour when up the country, or detached upon command, where in a frontier garriſon or hill fort in the interior parts of India none but natives are to be found. Here he might live as he pleaſes, being perfectly abſolute within his juriſdiction. Such ſtations being lucrative, with management may produce great fortunes. Neither is the condition hard to a perſon converſant in the language of the country, or that of the Seapoys called *Moors* (which moſt officers in the company's ſervice acquire); otherwiſe the loſs of ſociety is not recompenſed by other advantages, as you forget your own language, grow melancholy, and paſs your days without comfort.

The peace eſtabliſhment at Madras conſiſts of 30 Seapoy battalions, but in time of war is augmented as occaſion requires; or frequently each corps is ſtrengthened by the addition of two companies, which are reduced again in time of peace, the officers remaining ſupernumeraries in the ſervice. In garriſon they are quartered in barracks: they live agreeably to the uſage of the country, ſleep on the ground on a mat or thin carpet. In their perſons they are cleanly, but appear to beſt advantage in their uniform. Off duty they go as the other natives in poor circumſtances; and have only a cloth round their middle and over their ſhoulders. As to the different caſts, the Moormen or Muſſulmen affect pre-eminence, as coming into the country by conqueſt. In their perſons they are rather robuſt, and in their tempers vindictive. Their religion and dreſs is diſtinct from the Hindoos, who are mild and paſſive in their temper, faithful, ſteady, and good ſoldiers. The Pariars are inferior to the others, live under different circumſtances, dwell in huts, and aſſociate not on equal terms with the reſt; they do all menial offices, are ſervants to Europeans, and think themſelves happy when by them employed, though they are equally good Seapoys.

Having thus treated of the company's Seapoys, we ſhall obſerve that they are kindly attentive to their officers when often in circumſtances requiring their aſſiſtance; are guilty of few vices; and have a ſtrong attachment for thoſe who have commanded them. That acute hiſtorian Dr Robertſon has remarked, as a proof that the ingenuity of man has recourſe in ſimilar ſituations to the ſame expedients that the European powers, have, in forming the eſtabliſhment of theſe native troops, adopted the ſame maxims, and, probably without knowing it, have modelled their battalions of Seapoys upon the ſame principles as Alexander the Great did his phalanx of Perſians.

SEARCH-WARRANT, in *Law*, a kind of general warrant iſſued by juſtices of peace or magiſtrates of towns for ſearching all ſuſpected places for ſtolen goods. In Scotland this was often done formerly; and in ſome Engliſh law-books there are precedents requiring the conſtable to ſearch all ſuch ſuſpected places as he and the party complaining ſhall think convenient; but ſuch practice is condemned by Lord Hale, Mr Hawkins, and the beſt authorities both among the Engliſh and Scotch lawyers. However, in caſe of a complaint, and oath made of goods ſtolen, and that the party ſuſpects that thoſe goods are in a particular houſe, and ſhows the cauſe of ſuch ſuſpicion, the juſtice may grant a warrant to ſearch not only that houſe but other ſuſpected places; and to attach the goods, and the party in whoſe cuſtody they are found, and bring them before him or ſome other juſtice, to give an account how he came by them, and to abide ſuch order as to law ſhall appertain;

which warrant ſhould be directed to the conſtable or other public officer, who may enter a ſuſpected houſe and make ſearch.

SEARCHER, an officer in the cuſtoms, whoſe buſineſs it is to ſearch and examine ſhips outwards bound, if they have any prohibited goods on board, &c. (12 Car. II.). There are alſo ſearchers of leather, &c. See ALNAGER.

SEARCHER, in ordnance, is an iron ſocket with branches, from four to eight in number, a little bent outwards, with ſmall points at their ends; to this ſocket is fixed a wooden handle, from eight to twelve feet long, of about an inch and a quarter diameter. After the gun has been fired, this ſearcher is introduced into it, and turned round, in order to diſcover the cavities within. The diſtances of theſe cavities, if any be found, are then marked on the outſide with chalk, when another ſearcher that has only one point, about which a mixture of wax and tallow is put, is introduced to take the impreſſion of the holes; and if there be any hole, a quarter of an inch deep, or of any conſiderable length, the gun is rejected as unſerviceable.

SEARCLOTH, or CERECLOTH, in *Surgery*, a form of external remedy ſomewhat harder than an unguent, yet ſofter than an emplaſter, though it is frequently uſed both for the one and the other. The cerecloth is always ſuppoſed to have wax in its compoſition, which diſtinguiſhes and even denominates it. In effect, when a liniment or unguent has wax enough in it, it does not differ from a cerecloth.

SEASIN, in a ſhip, the name of a rope by which the boat rides by the ſhip's ſide when in harbour, &c.

SEASONING, the firſt illneſs to which perſons habituated to colder climates are ſubject on their arrival in the Weſt Indies. This ſeaſoning, unleſs they live very temperately, or are in a proper habit of body (though ſome people are unmoleſted for many months), ſeldom ſuffers them to remain long before it makes its appearance in ſome mode or other; particularly if at firſt they expoſe themſelves in a ſhower of rain, or too long in the ſun, or in the night-air; or when the body is much heated, if they drink large draughts of cold liquors, or bathe in cold water; or uſe much exerciſe; or commit exceſs in drinking wine or ſpirits; or by heating the body and inflaming the blood; or by ſubjecting themſelves to any cauſe that may ſuddenly check perſpiration, which at firſt is generally exceſſive.

Moſeley on Tropical Diſeaſes.

Some people, from a favourable ſtate of body, have no ſeaſoning. Thin people, and very young people, are moſt likely to eſcape it. Women generally do from their temperance, and perhaps their menſtruation contributes to their ſecurity; indeed hot climates are favourable to the delicacy of their habits, and ſuitable to their modes of life. Some eſcape by great regularity of living; ſome, by the breaking out of the raſh, called the *prickly heat*; ſome by a great degree of perſpiration; and ſome by obſerving a cooling regimen. The diſorders are various that conſtitute this ſeaſoning of *new-comers* as they are called; depending on age, conſtitution, and habit of body. But all ſeaſoning diſeaſes are of the inflammatory kind; and yield to antiphlogiſtic treatment proportioned to their violence. When all precaution to guard againſt ſickneſs has failed, and prudence proved abortive to new-comers, they will have this comfort at leaſt for their pains, that their diſorders will ſeldom be ſevere or expenſive, and will generally have a ſpeedy termination; and that their ſeaſoning, as it is emphatically called, will be removed by bleeding, a doſe of ſalts, reſt, and a cooling regimen.

SEASONING of Timber. See TIMBER.

SEASONS, in *Coſmography*, certain portions or quarters of the year, diſtinguiſhed by the ſigns which the ſun then enters, or by the meridian altitudes of the ſun; conſequent on which are different temperatures of the air, different works in tillage, &c. See WEATHER.

The year is divided into four ſeaſons, ſpring, ſummer, autumn, and winter. The beginnings and endings of each whereof, ſee under its proper article. It is to be obſerved, the ſeaſons anciently began differently from what they now do: witneſs the old verſes,

Dat Clemens hyemem; dat Petrus ver cathedratus;
Æſtuat Urbanus; autumnat Bartholomæus.

SEAT, in the manege, is the poſture or ſituation of a horſeman upon the ſaddle.

SEATON, a ſmall fiſhing town on the ſouth coaſt of Devon, between Lyme and Sidmouth. Riſdon ſays "our learned antiquarians would have it to be that *Maridunum* whereof Antonine ſpake, placed between Dunnovaria and Iſca; for *Maridunum* in Britiſh is the ſame with *Seaton* in Engliſh, "a town upon a hill by the ſea-ſide." This place is memorable for the Daniſh princes landing there in the year 937.

SEBACIC ACID, ſo called, becauſe it is procured from fat. For an account of its preparation and properties, ſee CHEMISTRY, page 540. and N° 802.

ST SEBASTIAN, a handſome, populous, and ſtrong town of Spain, in the province of Guipuſcoa, with a good and well frequented harbour. It is ſeated at the foot of a mountain; and the harbour ſecured by two moles, and a narrow entrance for the ſhips. The town is ſurrounded with a double wall, and to the ſea-ſide is fortified with baſtions and half moons. The ſtreets are long, broad, and ſtraight, and paved with white flagſtones. At the top of the mountain is a citadel, with a garriſon well furniſhed with cannon. The town carries on a conſiderable trade, the greateſt part of which conſiſts of iron and ſteel, which ſome reckon to be the beſt in Europe. They alſo deal in wood, which comes from Old Caſtile. W. Long. 1. 59. N. Lat. 43. 23.—The capital of Braſil in South America is likewiſe called *Sebaſtian*.

SEBASTIANO, called *Del Piombo*, from an office in the lead mines given him by Pope Clement VII. was an eminent Venetian painter, born in 1485. He was firſt a diſciple of old Giovanni Bellino; continued his ſtudies under Giorgione; and having attained an excellent manner of colouring, went to Rome, where he inſinuated himſelf into the favour of Michael Angelo. He has the name of being the firſt who invented the art of preparing plaſter-walls for oil-painting; but was ſo ſlow and lazy in his work, that other hands were often employed to finiſh what he began. He died in 1547.

SEBESTEN. See CORDIA, BOTANY *Index*.

SEBUÆI, a ſect among the ancient Samaritans, whom St Epiphanius accuſes of changing the time expreſſed in the law, for the celebration of the great annual feaſts of the Jews.

SEBURAI, SEBURÆI, a name which the Jews give to fuch of their rabbins or doctors as lived and taught fome time after the finifhing of the Talmud.

SECACUL, in the *Materia Medica* of the ancients, a name given by Avicenna, Serapion, and others, to a root which was like ginger, and was brought from the Eaft Indies, and ufed as a provocative to venery. The interpreters of their works have rendered this word *iringo;* and hence fome have fuppofed that our *eryngium* or *eryngo* was the root meant by it: but this does not appear to be the cafe on a ftrict inquiry, and there is fome reafon to believe that the famous root, at this time called *ginfeng*, was what they meant.

SECALE, RYE, a genus of plants belonging to the triandria clafs; and in the natural method ranking under the 4th order, *Gramina*. See BOTANY and AGRICULTURE *Index*.

The *cereale*, or common rye, has glumes with rough fringes. It is a native of the ifland of Candia, was introduced into England many ages ago, and is the only fpecies of rye cultivated in this kingdom. There are, however, two varieties, the winter and fpring rye.

The winter rye, which is larger in the grain than the fpring rye, is fown in autumn at the fame time with wheat, and fometimes mixed with it; but as the rye ripens fooner than the wheat, this method muft be very exceptionable. The fpring rye is fown along with the oats, and ufually ripens as foon as the winter rye; but the grain produced is lighter, and it is therefore feldom fown except where the autumnal crop has failed.

Rye is commonly fown on poor, dry, limeftone, or fandy foils, where wheat will not thrive. By continuing to fow it on fuch a foil for two or three years, it will at length ripen a month earlier than that which has been raifed for years on ftrong cold ground.

Rye is commonly ufed for bread either alone or mixed with wheat. This mixture is called *meflin*, and was formerly a very common crop in fome parts of Britain. Mr Marfhall tells us, that the farmers in Yorkfhire believe that this mixed crop is never affected by mildew, and that a fmall quantity of rye fown among wheat will prevent this deftructive difeafe. Rye is much ufed for bread in fome parts of Sweden and Norway by the poor people. About a century ago rye-bread was alfo much ufed in England; but being made of a black kind of rye, it was of the fame colour, clammy, very detergent, and confequently not fo nourifhing as wheat.

Rye is fubject to a difeafe which the French call *ergot*, and the Englifh *horned rye;* which fometimes happens when a very hot fummer fucceeds a rainy fpring. According to Tiffot, horned rye is fuch as fuffers an irregular vegetation in the middle fubftance between the grain and the leaf, producing an excrefcence of a brownifh colour, about an inch and a half long, and two-tenths of an inch broad. Bread made of this kind of rye has a naufeous acrid tafte, and produces fpafmodic and grangrenous diforders. In 1596, an epidemic difeafe prevailed in Heffe, which the phyficians afcribed to bread made of horned rye. Some, we are told, were feized with an epilepfy, and thefe feldom ever recovered; others became lunatic, and continued ftupid the reft of their lives: thofe who apparently recovered had annual returns of their diforder in January and February; and the difeafe was faid to be contagious at leaft in a certain degree. The facts which we have now mentioned are taken from a work of Tiffot, which was never printed. The fame difeafe was occafioned by the ufe of this bread in feveral parts of the continent in the years 1648, 1675, 1702, 1716, 1722, and 1736; and has been very minutely defcribed by Hoffman, A. O. Goelicke, Vater Burghart, and J. A. Srink.

In the year 1709, one fourth part of all the rye raifed in the province of Salonia in France was horned, and the furgeon to the hofpital of Orleans had no lefs than 500 patients under his care that were diftempered by eating it: They were called *ergots*, from *ergot* (A), the French name for horned rye; they confifted chiefly of men and boys, the number of women and girls being very fmall. The firft fymptom was a kind of drunkennefs, then the local diforder began in the toes, and thence extended fometimes to the thigh, and the trunk itfelf, even after amputation, which is a good argument againft that operation before the gangrene is ftopped.

In the year 1710, the celebrated Fontenelle defcribes a cafe in the Hiftory of the Academy of Sciences of France, which exactly refembles that of the poor family at Wattifham. A peafant at Blois, who had eaten horned rye in bread, was feized with a mortification which firft caufed all the toes of one foot to fall off, then the toes of the other, afterwards the remainder of the feet, and, laftly, it ate off the flefh of both his legs and thighs, leaving the bones bare.

Horned rye is not only hurtful to man, but to other animals; it has been known to deftroy even the flies that fettled upon it; fheep, dogs, deer, geefe, ducks, fwine, and poultry, that were fed with it for experiment, died miferably, fome convulfed, others mortified and ulcerated.

SECANT, in *Geometry*, a line that cuts another or divides it into parts. The fecant of a circle is a line drawn from the circumference on one fide to a point without the circumference on the other; and it is demonftrated by geometers, that of feveral fecants drawn to the fame point, that is the longeft which paffes through the centre of the circle. The portions, however, of thefe feveral fecants that are without the circle are fo much the greater as they recede from the centre, and the leaft external portion is of that fecant which paffes through it.

SECANT, in *Trigonometry*, denotes a right line drawn from the centre of a circle, which, cutting the circumference, proceeds till it meets with a tangent to the fame circle. See GEOMETRY.

Line of SECANTS, one of thofe lines or fcales which are ufually put upon fectors. See SECTOR, n° 12.

SECEDERS, a numerous body of Prefbyterians in Scotland, who have withdrawn from the communion of the eftablifhed church. As they take up their ground

(A) *Ergot* is French for a cock's fpur, and horned rye was called *ergot* from the refemblance of its excrefcence to that part.

Seceders. ground upon the eſtabliſhment of religion from 1638 to 1650, which they hold to be the pureſt period of the Scottiſh church, we ſhall introduce our account of them by a ſhort view of eccleſiaſtical hiſtory from that period to the era of their ſeceſſion. With our uſual candour and impartiality we mean to give a fair ſtatement of thoſe events with which, as they ſay, their ſeceſſion is connected.

James I. having for ſome time previous to his death entertained a wiſh to form the church of Scotland as much as poſſible upon the model of that in England, his ſon Charles, with the aſſiſtance of Archbiſhop Laud, endeavoured to carry the deſign into execution, by eſtabliſhing canons for eccleſiaſtical diſcipline, and introducing a liturgy into the public ſervice of the church.—Numbers of the clergy and laity of all ranks took the alarm at what they conſidered to be a bold and dangerous innovation; and after frequent applications to the throne, they at laſt obtained the royal proclamation for a free parliament and general aſſembly. The aſſembly met in 1638, and began their labours with a repeal of all the acts of the ſix preceding parliaments, which had favoured the deſigns of James. They condemned the liturgy, together with every branch of the hierarchy. They cited all the Scottiſh biſhops to their bar; and after having excommunicated nine of them, and depoſed five from their epiſcopal office, they reſtored kirk-ſeſſions, preſbyteries, and ſynods provincial as well as national. See PRESBYTERIANS.

Theſe proceedings were ratified by the parliament which met in 1640. The law of patronage was in full force for ſeveral years after this period; yet great care was taken that no miniſter ſhould be obtruded on the Chriſtian people contrary to their inclinations; and in 1649 it was aboliſhed as an oppreſſive grievance.

The reſtoration of Charles II. in 1660 changed the face of affairs in the church of Scotland. All that the general aſſembly had done from 1638 to 1650 was rendered null and void, the covenants were pronounced to be unlawful, epiſcopacy was reſtored, and the king was declared to be the ſupreme head of the church in all cauſes civil and eccleſiaſtical. During this period the Preſbyterians were ſubjected to fines and impriſonment, while numbers of them were publicly executed for their adherence to their political and religious tenets.

The Revolution in 1688 gave a different turn to the affairs of the church. The firſt parliament which met after that event, aboliſhed prelacy and the king's ſupremacy in eccleſiaſtical affairs. They ratified the Weſtminſter Confeſſion of Faith, together with the Preſbyterian form of church-government and diſcipline, "as agreeable to the word of God, and moſt conducive to the advancement of true piety and godlineſs, and the eſtabliſhment of peace and tranquillity within theſe realms." That ſame parliament aboliſhed patronage, and lodged the election of miniſters in the hands of heritors and elders, with the conſent of the congregation.

In the reign of Queen Anne the true Proteſtant religion was ratified and eſtabliſhed, together with the Preſbyterian form of church-government and diſcipline; and the unalterable continuance of both was declared to be an eſſential condition of the union of the two kingdoms in all time coming. In 1712 the law reſpecting patronage was revived, in reſentment, it has been ſaid, of that warm attachment which the church of Scotland diſcovered to the family of Hanover; but the ſeverity of that law was greatly mitigated by the firſt parliament of George I. ſtat. 50. by which it is enacted, that, if the preſentee do not ſignify his acceptance, the preſentation ſhall become void and null in law. The church, however, did not avail herſelf of this ſtatute; and an event which happened not many years afterwards gave riſe to the *ſeceſſion*.

2 Origin of

In 1732 more than 40 miniſters preſented an addreſs to the general aſſembly, ſpecifying in a variety of inſtances what they conſidered to be great defections from the eſtabliſhed conſtitution of the church, and craving a redreſs of theſe grievances. A petition to the ſame effect, ſubſcribed by ſeveral hundreds of elders and private Chriſtians, was offered at the ſame time; but the aſſembly refuſed a hearing to both, and enacted, that the election of miniſters to vacant charges, where an accepted preſentation did not take place, ſhould be competent only to a conjunct meeting of elders and heritors, being Proteſtants. To this act many objections were made by numbers of miniſters and private Chriſtians. They aſſerted that more than 30 to one in every pariſh were not poſſeſſed of landed property, and were on that account deprived of what they deemed their natural right to chooſe their own paſtors. It was alſo ſaid, that this act was extremely prejudicial to the honour and intereſt of the church, as well as to the edification of the people; and in fine, that it was directly contrary to the appointment of Jeſus Chriſt, and the practice of the apoſtles, when they filled up the firſt vacancy in the apoſtolic college, and appointed the election of deacons and elders in the primitive church.—Many of thoſe alſo who were thought to be the beſt friends of the church, expreſſed their fears that this act would have a tendency to overturn the eccleſiaſtical conſtitution which was eſtabliſhed at the Revolution.

3 They oppoſe the meaſures of the general aſſembly;

Mr Ebenezer Erſkine, miniſter at Stirling, diſtinguiſhed himſelf by a bold and determined oppoſition to the meaſures of the aſſembly in 1732. Being at that time moderator of the ſynod of Perth and Stirling, he opened the meeting at Perth with a ſermon from Pſalm cxviii. 22. "The ſtone which the builders rejected is become the head ſtone of the corner." In the courſe of his ſermon he remonſtrated with no ſmall degree of freedom againſt the act of the preceding aſſembly with regard to the ſettlement of miniſters, and alleged that it was contrary to the word of God and the eſtabliſhed conſtitution of the church. A formal complaint was lodged againſt him for uttering ſeveral offenſive expreſſions in his ſermon before the ſynod. Many of the members declared that they heard him utter nothing but ſound and ſeaſonable doctrine; but his accuſers inſiſting on their complaint, obtained an appointment of a committee of ſynod to collect what were called the offenſive expreſſions, and to lay them before the next diet in writing. This was done accordingly; and Mr Erſkine gave in his anſwers to every article of the complaint. After three days warm reaſoning on this affair, the ſynod by a majority of ſix found him cenſurable; againſt which ſentence he proteſted, and appealed to the next general aſſembly. When the aſſembly met in May 1733, it affirmed the ſentence of the ſynod, and appointed Mr Erſkine to be rebuked

4 For which their miniſters are cenſured,

and

Seceders. and admoniſhed from the chair. Upon which he proteſted, that, as the aſſembly had found him cenſurable, and had rebuked him for doing what he conceived to be agreeable to the word of God and the ſtandards of the church, he ſhould be at liberty to preach the ſame truths, and to teſtify againſt the ſame or ſimilar evils, on every proper occaſion. To this proteſt Meſſrs William Wilſon miniſter at Perth, Alexander Moncrief miniſter at Abernethy, and James Fiſher miniſter at Kinclaven, gave in a written adherence, under the form of inſtrument; and theſe four withdrew, intending to return to their reſpective charges, and act agreeably to their proteſt whenever they ſhould have an opportunity. Had the affair reſted here, there never would have been a ſeceſſion; but the aſſembly reſolving to carry on the proceſs, cited them by their officer to compear next day. They obeyed the citation; and a committee was appointed to retire with them, in order to perſuade them to withdraw their proteſt. The committee having reported that they ſtill adhered to their proteſt, the aſſembly ordered them to appear before the commiſſion in Auguſt following and retract their proteſt; and if they ſhould not comply and teſtify their ſorrow for their conduct, the commiſſion was empowered to ſuſpend them from the exerciſe of their miniſtry, with certification that if they ſhould act contrary to ſaid ſentence, the commiſſion ſhould proceed to an higher cenſure.

5 Suſpended from the exerciſe of their office,

The commiſſion met in Auguſt accordingly; and the four miniſters ſtill adhering to their proteſt, were ſuſpended from the exerciſe of their office, and cited to the next meeting of the commiſſion in November following. From this ſentence ſeveral miniſters and elders, members of the commiſſion, diſſented. The commiſſion met in November, and the ſuſpended miniſters compeared. Addreſſes, repreſentations, and letters from ſeveral ſynods and preſbyteries, relative to the buſineſs now before the commiſſion, were received and read. The ſynods of Dumfries, Murray, Roſs, Angus and Mearns, Perth and Stirling, craved that the commiſſion would delay proceeding to a higher cenſure. The ſynods of Galloway and Fife, as alſo the preſbytery of Dornoch, addreſſed the commiſſion for lenity, tenderneſs, and forbearance, towards the ſuſpended miniſters; and the preſbytery of Aberdeen repreſented, that in their judgement, the ſentence of ſuſpenſion inflicted on the foreſaid miniſters was too high, and that it was a ſtretch of eccleſiaſtical authority. Many members of the commiſſion reaſoned in the ſame manner, and alleged that the act and ſentence of laſt aſſembly did not oblige them to proceed to an higher cenſure at this meeting of the commiſſion. The queſtion, however, was put, Proceed to an higher cenſure, or not? and the votes being numbered, were found equal on both ſides: upon which Mr John Goldie the moderator gave his caſting vote to proceed to a higher cenſure; which ſtands in their minutes in theſe words: "The commiſſion did and hereby do looſe the relation of Mr Ebenezer Erſkine miniſter at Stirling, Mr William Wilſon miniſter at Perth, Mr Alexander Moncrief miniſter at Abernethy,

6 deprived of their livings;

and Mr James Fiſher miniſter at Kinclaven, to their reſpective charges, and declare them no longer miniſters of this church; and do hereby prohibit all miniſters of this church to employ them, or any of them, in any miniſterial function. And the commiſſion do declare the churches of the ſaid miniſters vacant from and after the date of this ſentence."

This ſentence being intimated to them, they proteſted, that their miniſterial office and relation to their reſpective charges ſhould be held *as* valid as if no ſuch ſentence had paſſed; and that they were now obliged to make a *ſeceſſion* from the prevailing party in the eccleſiaſtical courts; and that it ſhall be lawful and warrantable for them to preach the goſpel, and diſcharge every branch of the paſtoral office, according to the word of God and the eſtabliſhed principles of the church of Scotland. Mr Ralph Erſkine miniſter at Dunfermline, Mr Thomas Mair miniſter at Orwel, Mr John M'Laren miniſter at Edinburgh, Mr John Currie miniſter at Kinglaſſie, Mr James Wardlaw miniſter at Dunfermline, and Mr Thomas Nairn miniſter at Abbotſhal, proteſted againſt the ſentence of the commiſſion, and that it ſhould be lawful for them to complain of it to any ſubſequent general aſſembly of the church.

The ſeceſſion properly commenced at this date. And accordingly the ejected miniſters declared in their proteſt that they were laid under the diſagreeable neceſſity of ſeceding, not from the principles and conſtitution of the church of Scotland, to which, they ſaid, they ſtedfaſtly adhered, but from the preſent church-courts, which had thrown them out from miniſterial communion. The aſſembly, however, which met in May 1734 did ſo far modify the above ſentence, that they empowered the ſynod of Perth and Stirling to receive the ejected miniſters into the communion of the church, and reſtore them to their reſpective charges; but with this expreſs direction, "that the ſaid ſynod ſhould not take upon them to judge of the legality or formality of the former procedure of the church judicatories in relation to this affair, or either approve or cenſure the ſame." As this appointment neither condemned the act of the preceding aſſembly nor the conduct of the commiſſion, the ſeceding miniſters conſidered it to be rather an act of grace than of juſtice, and therefore they ſaid they could not return to the church-courts upon this ground; and they publiſhed to the world the reaſons of their refuſal, and the terms upon which they were willing to return to the communion of the eſtabliſhed church. They now erected themſelves into an eccleſiaſtical court, which they called the *Aſſociated Preſbytery*, and preached occaſionally to numbers of the people who joined them in different parts of the country. They alſo publiſhed what they called an *Act, Declaration, and Teſtimony*, to the doctrine, worſhip, government, and diſcipline of the church of Scotland, and againſt ſeveral inſtances, as they ſaid, of defection from theſe, both in former and in the preſent times. Some time after this ſeveral miniſters of the eſtabliſhed church joined them, and the Aſſociated Preſbytery now conſiſted of eight miniſters. But the general aſſembly which met in 1738 finding that the number of Seceders was much increaſed, ordered the eight miniſters to be ſerved with a libel, and to be cited to the next meeting of the aſſembly in 1739. They now appeared at the bar as a conſtituted preſbytery, and having formally declined the aſſembly's authority, they immediately withdrew. The aſſembly which met next year depoſed them from the office of the miniſtry; which, however, they continued to exerciſe in their reſpective congregations, who ſtill adhered to them, and erected meeting houſes, where they preached till their

7 and degraded.

Seceders their death. Mr James Fisher, the last survivor of them, was, by an unanimous call in 1741, translated from Kinclaven to Glasgow, where he continued in the exercise of his ministry among a numerous congregation, respected by all ranks in that large city, and died in 1775 much regretted by his people and friends. In 1745 the seceding ministers were become so numerous, that they were erected into three different presbyteries, under one synod, when a very unprofitable dispute divided them into two parties.

8
They divide among themselves about the legality of the burgess oath.

The burgess oath in some of the royal boroughs of Scotland contains the following clause: "I profess and allow with my heart the true religion presently professed within this realm, and authorized by the laws thereof. I will abide at and defend the same to my life's end, renouncing the Romish religion called *Papistry*." Messrs Ebenezer and Ralph Erskine, James Fisher, and others, affirmed that this clause was no way contrary to the principles on which the secession was formed, and that therefore every Seceder might lawfully swear it. Messrs Alexander Moncrief, Thomas Mair, Adam Gib, and others, contended on the other hand that the swearing of the above clause was a virtual renunciation of their testimony. And this controversy was so keenly agitated, that they split into two different parties, and now met in different synods. Those of them who assert the lawfulness of swearing the burgess oath are called *Burghers*, and the other party who condemn it are called *Antiburgher Seceders*. Each party claiming to itself the lawful constitution of the *Associate Synod*, the Antiburghers, after several previous steps, excommunicated the Burghers on the ground of their sin and of their contumacy in it. This rupture took place in 1747, since which period no attempts to effect a reunion have been successful. They remain under the jurisdiction of different synods, and hold separate communion, although much of their former hostility has been laid aside. The Antiburghers consider the Burghers as too lax and not sufficiently stedfast to their testimony. The Burghers on the other hand contend that the Antiburghers are too rigid, in that they have introduced new terms of communion into the society. The Antiburghers having adopted ideas with regard to what they call *covenanting*, which the Burghers never approved (A), have been in use of renewing in their several congregations the Scottish Covenant, by causing their people formally swear to maintain it. In other respects the differences between the two parties are not material. The Antiburghers are most numerous on the north of the Tay, and the Burghers on the south of it.

9
and form separate communions.

10
History of the Burgher Seceders.

What follows in this article is a further account of those who are commonly called the *Burgher Seceders*. These have a greater number of people in their communion than the Antiburghers, and for some years past they have greatly increased in the southern and western districts of Scotland. As there were among them from the commencement of their secession several students who had been educated at one or other of the universities, they appointed one of their ministers to give lectures in theology, and train up candidates for the ministry. Messrs William Wilson minister at Perth and Alexander Moncrief minister at Abernethy were their professors of theology before their separation from the Antiburghers.

Since that period Mr Ebenezer Erskine minister at Stirling, Mr James Fisher minister at Glasgow, Mr John Swanston minister at Kinross, and Mr John Brown minister at Haddington, have succeeded each other in this office. At present Mr George Lawson minister at Selkirk is their professor of theology, and there are between thirty and forty students who attend his lectures annually. The number of their ministers is about an hundred, and each of their congregations contains from two hundred and fifty to three thousand persons; and there are among them at present more than twenty vacant charges. Where a congregation is very numerous, as in Stirling, Dunfermline, and Perth, it is formed into a collegiate charge, and provided with two ministers. They are erected into six different presbyteries, united in one general synod, which commonly meets at Edinburgh in May and September (B). They have also a synod in Ireland composed of three or four different presbyteries. They are legally tolerated in Ireland; and government some years ago granted 500l. per annum, and of late an additional 500l. which, when divided among them, affords to each minister about 20l. over and above the stipend which he receives from his hearers. These have besides a presbytery in Nova Scotia; and some years ago, it is said, that the Burgher and the Antiburgher ministers residing in the United States formed a coalition and joined in a general synod, which they call the *Synod* of *New York* and *Pennsylvania*. They all preach the doctrines contained in the Westminster Confession of Faith and Catechisms, as they believe these to be founded on the sacred scriptures. They catechise their hearers publicly, and visit them from house to house once every year.

(A) This is the account which the Burghers give of their own notions respecting the covenant. One of the most enlightened of their opponents, however, assures us that they acknowledge covenanting to be a *moral duty*, and that the solemn vows of our ancestors are obligatory. But since the breach in the synod they have never engaged in this work; giving, as their reason, that this is not the proper season.

(B) The constitution of the Antiburgher church differs very little from that of the Burghers. The supreme court among them is designed *The General Associate Synod*, having under its jurisdiction three provincial synods in Scotland and one in Ireland. In the former country there are eleven presbyteries; in the latter, four. They have a few congregations in England, and a presbytery in connection with them in North America. The number of ministers belonging to the general synod is a hundred and thirty-seven; and in Scotland there are nineteen vacancies. They, as well as the Burgher Seceders, have a professor of theology, whose lectures every candidate for the office of a preacher is obliged to attend, we have been told, for no less than five or six sessions! Surely the session must be of short duration.

Seceders. year. They will not give the Lord's ſupper to thoſe who are ignorant of the principles of the goſpel, nor to ſuch as are ſcandalous and immoral in their lives. They condemn private baptiſm, nor will they admit thoſe who are groſsly ignorant and profane to be ſponſors for their children. Believing that the people have a natural right to chooſe their own paſtors, the ſettlement of their miniſters always proceeds upon a popular election; and the candidate who is elected by the majority is ordained among them. Convinced that the charge of ſouls is a truſt of the greateſt importance, they carefully watch over the morals of their ſtudents, and direct them to ſuch a courſe of reading and ſtudy as they judge moſt proper to qualify them for the profitable diſcharge of the paſtoral duties. At the ordination of their miniſters they uſe a *formula* of the ſame kind with that of the eſtabliſhed church, which their miniſters are bound to ſubſcribe when called to it; and if any of them teach doctrines contrary to the Scriptures or the Weſtminſter Confeſſion of Faith, they are ſure of being thrown out of their communion. By this means uniformity of ſentiment is preſerved among them; nor has any of their miniſters, excepting one, been proſecuted for error in doctrine ſince the commencement of their ſeceſſion.

11 Their rules of faith,

They believe that the holy ſcriptures are the ſole criterion of truth, and the only rule to direct mankind to glorify and enjoy God, the chief and eternal good; and that "the Supreme Judge, by which all controverſies of religion are to be determined, and all the decrees of councils, opinions of ancient writers, doctrines of men and private ſpirits, are to be examined, and in whoſe ſentence we are to reſt, can be no other but the Holy Spirit ſpeaking in the Scriptures." They are fully perſuaded, however, that the ſtandards of public authority in the church of Scotland exhibit a juſt and conſiſtent view of the meaning and deſign of the holy ſcriptures with regard to doctrine, worſhip, government, and diſcipline; and they in ſo far differ from the diſſenters in England, in that they hold theſe ſtandards to be not only articles of peace and a teſt of orthodoxy, but as a bond of union and fellowſhip. They conſider a ſimple declaration of adherence to the ſcriptures as too equivocal a proof of unity in ſentiment, becauſe Arians, Socinians, and Arminians, make ſuch a confeſſion of their faith, while they retain ſentiments which they (the Seceders) apprehend are ſubverſive of the great doctrines of the goſpel. They believe that Jeſus Chriſt is the only King and Head of the Church, which is his body; that it is his ſole prerogative to enact laws for the government of his kingdom, which is not of this world; and that the church is not poſſeſſed of a legiſlative, but only of an executive power, to be exerciſed in explaining and applying to their proper objects and ends thoſe laws which Chriſt hath publiſhed in the ſcriptures. Thoſe doctrines which they teach relative to faith and practice are exhibited at great length in an explanation of the Weſtminſter Aſſembly's Shorter Catechiſm, by way of queſtion and anſwer, in two volumes, compoſed chiefly by Mr James Fiſher late of Glaſgow, and publiſhed by deſire of their ſynod.

For theſe 50 years paſt, the grounds of their ſeceſſion, they allege, have been greatly enlarged by the public adminiſtrations of the eſtabliſhed church, and particularly by the uniform execution of the law reſpecting patronage, which, they ſay, has obliged many thouſands of private Chriſtians to withdraw from the pariſh-churches and join their ſociety.

It is certain, however, that their number has rapidly increaſed of late, eſpecially in the large cities of the kingdom. They have three different congregations in Edinburgh, two in Glaſgow, and two in London, beſides ſeveral others in the north of England. In moſt of their congregations they celebrate the Lord's ſupper twice in the year, and they catechiſe their young people concerning their knowledge of the principles of religion previouſly to their admiſſion to that ſacrament. When any of them fall into the ſin of fornication or adultery, the ſcandal is regularly purged according to the form of proceſs in the eſtabliſhed church; and thoſe of the delinquents who do not ſubmit to adequate cenſure are publicly declared to be fugitives from diſcipline, and are expelled the ſociety. They never accept a ſum of money as a commutation for the offence. They condemn all clandeſtine and irregular marriages, nor will they marry any perſons unleſs they have been proclaimed in the pariſh-church on two different Lord's days at leaſt. 12

When they ſeparated from the eſtabliſhed church, they remained firm in their attachment to the ſtate; and they were not many years formed into a diſtinct ſociety, when they expelled from their communion a Mr Thomas Nairn miniſter at Kirkcaldy, who had taught doctrines inimical to the civil government of the nation. In 1745 there was not one of their number who joined the pretender to the Britiſh crown. They are ſtill of the ſame ſentiments; and in their public aſſemblies they always pray for our ſovereign King George, with the royal family, and for all who are in authority under them. They are ſo far from wiſhing the overthrow of the preſent civil government, that when the nation was lately in danger of being thrown into a fermentation by the circulation of inflammatory and ſeditious writings, they warmly recommended peace and order in ſociety. The ſame remarks, we believe, are equally applicable to the Antiburgher ſeceders. No legal diſqualifications, as in the caſe of the diſſenters in England, exclude them from any place of public truſt in the municipal government of the country; and ſome of them are frequently in the magiſtracy of the royal boroughs. They are not, however, legally tolerated, but are ſupported by the mildneſs of adminiſtration and the liberal ſpirit of the times. Avowing their adherence to the doctrines contained in the public ſtandards of the church of Scotland, together with the preſbyterian form of government, from which they never intended to ſecede, they deny that they are either ſchiſmatics or ſectaries, as they have been frequently called: and when they withdrew from the eccleſiaſtical courts, they did not, they ſay, conſtitute a church of their own, different from the national church, but profeſs to be a part of that church, endeavouring to hold by her reformed principles, in oppoſition to thoſe deviations from them which they have ſpecified in their *Act and Teſtimony*. Moſt of them live in habits of friendſhip and intimacy with their brethren of the eſtabliſhment, and they profeſs an affectionate regard for all thoſe of every denomination who love Jeſus Chriſt in ſincerity and truth. In the late re-exhibition of their teſtimony, they have declared to the world, that, were the grounds of their ſeceſſion happily removed, they would account it one of the moſt ſingular felicities of

and political principles.

13 Their moderation.

their

their time to return with pleasure to the communion of the established church.

SECHIUM, a genus of plants belonging to the monœcia class; and in the natural method ranking under the 34th order, *Cucurbitaceæ*. See BOTANY *Index*.

SECKENDORF, GUY LEWIS DE, a very learned German, descended from an ancient and noble family, was born at Aurach in Franconia in 1626. He was a good linguist, learned in law, history, and divinity; and is said to have been a tolerable painter and engraver. He was honourably employed by several of the German princes; and died counsellor of state to Frederic III. elector of Brandenburg, and chancellor of the university of Halle, in 1692. He wrote many books, particularly "A history and defence of the Lutheran religion," 2 vols folio, Frankfort, 1602, in Latin.

SECKER, THOMAS, a learned and respectable prelate of the church of England, was born, in 1693, at a village called *Sibthorp*, in the vale of Belvoir, in Nottinghamshire. His father was a Protestant dissenter, a pious, virtuous, and sensible man; who, having a small paternal fortune, followed no profession. His mother was the daughter of Mr Brough, a substantial gentleman farmer of Shelton in the same county. He received his education at several private schools and academies in the country, being obliged, by various accidents, frequently to change his masters.

Notwithstanding this disadvantage, he had at the age of 19 not only made considerable progress in Greek and Latin, and read the best writers in both languages, but had acquired a knowledge of French, Hebrew, Chaldee, and Syriac; had learned geography, logic, algebra, geometry, conic sections, and gone through a course of lectures on Jewish antiquities and other points, preparatory to the critical study of the Bible. He had been destined by his father for orders among the Dissenters. With this view, during the latter years of his education, his studies were chiefly turned towards divinity, in which he had made such quick advances, that by the time he was 23 he had carefully read over a great part of the Scriptures, particularly the New Testament, in the original, and the best comments upon it; Eusebius's Ecclesiastical History, The Apostolical Fathers, Whiston's Primitive Christianity, and the principal writers for and against Ministerial and Lay Conformity.—But though the result of these inquiries was a well-grounded belief of the Christian revelation, yet not being at that time able to decide on some abstruse speculative doctrines, nor to determine absolutely what communion he should embrace; he resolved, like a wise and honest man, to pursue some profession, which should leave him at liberty to weigh those things more maturely in his thoughts, and not oblige him to declare or teach publicly opinions which were not yet thoroughly settled in his own mind.

In 1716, therefore, he applied himself to the study of physic, and after gaining all the medical knowledge he could, by reading the usual preparatory books, and attending the best lectures during that and the following winter in London, in order to improve himself farther, in January 1718-19 he went to Paris. There he lodged in the same house with the famous anatomist Mr Winslow, whose lectures he attended, as he did those of the materia medica, chemistry, and botany, at the king's gardens. He saw the operations of surgery at the *Hotel Dieu*, and attended also for some time M. Gregoire, the accoucheur, but without any design of ever practising that or any other branch of surgery. Here he became acquainted with Mr Martin Benson, afterwards bishop of Gloucester, one of the most agreeable and virtuous men of his time; with whom he quickly became much connected, and not many years after was united to him by the strictest bonds of affinity as well as affection.

During the whole of Mr Secker's continuance at Paris, he kept up a constant correspondence with Mr Joseph Butler, afterwards bishop of Durham, with whom he became acquainted at the academy of one Mr Jones, kept first at Gloucester, and afterward at Tewksbury. Mr Butler having been appointed preacher at the Rolls on the recommendation of Dr Clarke and Mr Edward Talbot, son to Bishop Talbot, he now took occasion to mention his friend Mr Secker, without Secker's knowledge, to Mr Talbot, who promised, in case he chose to take orders in the church of England, to engage the bishop his father to provide for him. This was communicated to Mr Secker in a letter from Mr Butler about the beginning of May 1720. He had not at that time come to any resolution of quitting the study of physic; but he began to foresee many obstacles to his pursuing that profession; and having never discontinued his application to theology, his former difficulties both with regard to conformity and some other doubtful points had gradually lessened, as his judgement became stronger, and his reading and knowledge more extensive. It appears also from two of his letters still in being, written from Paris to a friend in England, (both of them prior to the date of Mr Butler's above mentioned), that he was greatly dissatisfied with the divisions and disturbances which at that particular period prevailed among the Dissenters.

In this state of mind Mr Butler's unexpected proposal found him; which he was therefore very well disposed to take into consideration; and after deliberating on the subject of such a change for upwards of two months, he resolved at length to embrace the offer, and for that purpose quitted France about the beginning of August 1720.

On his arrival in England, he was introduced to Mr Talbot, with whom he cultivated a close acquaintance; but it was unfortunately of very short duration; for in the month of December that gentleman died of the smallpox. This was a great shock to all his friends, who had justly conceived the highest expectations of him; but especially to an amiable lady whom he had lately married, and who was very near sinking under so sudden and grievous a stroke. Mr Secker, beside sharing largely in the common grief, had peculiar reason to lament an accident that seemed to put an end to all his hopes; but he had taken his resolution, and he determined to persevere. It was some encouragement to him to find that Mr Talbot had, on his deathbed, recommended him, together with Mr Benson and Mr Butler, to his father's notice. Thus did that excellent young man (for he was but 29 when he died), by his nice discernment of characters, and his considerate good nature, provide most effectually, in a few solemn moments, for the welfare of that church from which he himself was so prematurely snatched away; and at the same

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ſame time raiſed up, when he leaſt thought of it, the trueſt friend and protector to his wife and unborn daughter; who afterwards found in Mr Secker all that tender care and aſſiſtance which they could have hoped for from the neareſt relation.

It being judged neceſſary by Mr Secker's friends that he ſhould have a degree at Oxford; and having been informed, that if he ſhould previouſly take the degree of Doctor in Phyſic at Leyden, it would probably help him in obtaining the other, he went over and took his degree there in March 1721: and, as part of his exerciſe for it, he compoſed and printed a diſſertation *de Medicina Statica*, which is ſtill extant, and is thought by the gentlemen of that profeſſion to be a ſenſible and learned performance.

In April the ſame year, he entered himſelf a gentleman commoner of Exeter college, Oxford; after which he obtained the degree of Bachelor of Arts, in conſequence of the chancellor's recommendatory letter to the convocation.

He now ſpent a conſiderable part of his time in London, where he quickly gained the eſteem of ſome of the moſt learned and ingenious men of thoſe days, particularly of Dr Clarke, rector of St James's, and the celebrated Dean Berkeley, afterwards biſhop of Cloyne, with whom he every day became more delighted, and more cloſely connected. He paid frequent viſits of gratitude and friendſhip to Mrs Talbot, widow of Mr Edward Talbot, by whom ſhe had a daughter five months after his deceaſe. With her lived Mrs Catharine Benſon, ſiſter to Biſhop Benſon, whom in many reſpects ſhe greatly reſembled. She had been for ſeveral years Mrs Talbot's inſeparable companion, and was of unſpeakable ſervice to her at the time of her huſband's death, by exerting all her courage, activity, and good ſenſe (of which ſhe poſſeſſed a large ſhare), to ſupport her friend under ſo great an affliction, and by afterwards attending her ſickly infant with the utmoſt care and tenderneſs, to which, under Providence, was owing the preſervation of a very valuable life.

Biſhop Talbot being in 1721 appointed to the ſee of Durham, Mr Secker was in 1722 ordained deacon by him in St James's church, and prieſt not long after in the ſame place, where he preached his firſt ſermon March 28. 1723. The biſhop's domeſtic chaplain at that time was Dr Rundle, a man of warm fancy and very brilliant converſation, but apt ſometimes to be carried by the vivacity of his wit into indiſcreet and ludicrous expreſſions, which created him enemies, and, on one occaſion, produced diſagreeable conſequences.—With him Mr Secker was ſoon after aſſociated in the biſhop's family, and both taken down by his lordſhip to Durham in July 1723.

In the following year the biſhop gave Mr Secker the rectory of Houghton-le-Spring. This preferment putting it in his power to fix himſelf in the world, in a manner agreeable to his inclinations, he ſoon after made a propoſal of marriage to Mrs Benſon; which being accepted, they were married by Biſhop Talbot in 1725. At the earneſt requeſt of both, Mrs Talbot and her daughter conſented to live with them, and the two families from that time became one.

About this time Biſhop Talbot alſo gave preferments to Mr Butler and Mr Benſon, whoſe riſe and progreſs in the church is here interwoven with the hiſtory of Mr Secker. In the winter of 1725-6, Mr Butler firſt publiſhed his incomparable ſermons; on which, as Dr Beilby Porteous and Dr Stinton inform us, Mr Secker took pains to render the ſtyle more familiar, and the author's meaning more obvious: yet they were at laſt by many called obſcure. Mr Secker gave his friend the ſame aſſiſtance in that noble work the Analogy of Religion, &c.

He now gave up all the time he poſſibly could to his reſidence at Houghton, applying himſelf with alacrity to all the duties of a country clergyman, and ſupporting that uſeful and reſpectable character throughout with the ſtricteſt propriety. He omitted nothing which he thought would be of uſe to the ſouls and bodies of the people entruſted to his care. He brought down his converſation and his ſermons to the level of their underſtandings; he viſited them in private, he catechiſed the young and ignorant, he received his country neighbours and tenants very kindly and hoſpitably, and was of great ſervice to the poorer ſort of them by his ſkill in phyſic, which was the only uſe he ever made of it. Though this place was in a very remote part of the world, yet the ſolitude of it perfectly ſuited his ſtudious diſpoſition, and the income ariſing from it bounded his ambition. Here he would have been content to live and die; here, as he has often been heard to declare, he ſpent ſome of the happieſt hours of his life; and it was no thought or choice of his own that removed him to a higher and more conſpicuous ſituation; but Mrs Secker's health, which now began to decline, and was thought to be injured by the dampneſs of the ſituation, obliged him to think of exchanging it for a more healthy one. Accordingly, an exchange was made through the friendly interpoſition of Mr Benſon (who generouſly ſacrificed his own intereſt on this occaſion, by relinquiſhing a prebend of his own to ſerve his friend) with Dr Finney, prebendary of Durham, and rector of Ryton; and Mr Secker was inſtituted to Ryton and the prebend June 3. 1727. For the two following years he lived chiefly at Durham, going every week to officiate at Ryton, and ſpending there two or three months together in the ſummer.

In July 1732 he was appointed chaplain to the king; for which favour he was indebted to Dr Sherlock, who having heard him preach at Bath, had conceived the higheſt opinion of his abilities, and thought them well worthy of being brought forward into public notice. From that time an intimacy commenced between them, and he received from that great prelate many ſolid proofs of eſteem and friendſhip.

His month of waiting at St James's happened to be Auguſt, and on Sunday the 27th of that month he preached before the queen, the king being then abroad. A few days after, her majeſty ſent for him into her cloſet, and held a long converſation with him; in the courſe of which he took an opportunity of mentioning to her his friend Mr Butler. He alſo, not long after this, on Mr Talbot's being made lord chancellor, found means to have Mr Butler effectually recommended to him for his chaplain. The queen alſo appointed him clerk of her cloſet; from whence he roſe, as his talents became more known, to thoſe high dignities which he afterwards attained.

Mr Secker now began to have a public character, and ſtood high in the eſtimation of thoſe who were allowed

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lowed to be the best judges of merit: he had already given proofs of abilities that plainly indicated the eminence to which he must one day rise, as a preacher and a divine; and it was not long before an opportunity offered of placing him in an advantageous point of view. Dr Tyrrwhit, who succeeded Dr Clarke as rector of St James's in 1729, found that preaching in so large a church endangered his health. Bishop Gibson, therefore, his father-in-law, proposed to the crown that he should be made residentiary of St Paul's, and that Mr Secker should succeed him in the rectory. This arrangement was so acceptable to those in power, that it took place without any difficulty. Mr Secker was instituted rector the 18th of May 1733; and in the beginning of July went to Oxford to take his degree of Doctor of Laws, not being of sufficient standing for that of divinity. On this occasion it was that he preached his celebrated Act Sermon, on the advantages and duties of academical education, which was universally allowed to be a masterpiece of sound reasoning and just composition: it was printed at the desire of the heads of houses, and quickly passed through several editions. It is now to be found in the second collection of Occasional Sermons, published by himself in 1766.

It was thought that the reputation he acquired by this sermon, contributed not a little toward that promotion which very soon followed its publication. For in December 1734, he received a very unexpected notice from Bishop Gibson, that the king had fixed on him to be bishop of Bristol. Dr Benson was about the same time appointed to the see of Gloucester, as was Dr Fleming to that of Carlisle; and the three new bishops were all consecrated together in Lambeth Chapel, Jan. 19. 1734-5, the consecration-sermon being preached by Dr Thomas, afterwards bishop of Winchester.

The honours to which Dr Secker was thus raised in the prime of life did not in the least abate his diligence and attention to business; for which, indeed, there was now more occasion than ever. His learned biographers, Messrs Porteous and Stinton, now relate the manner in which he set about the visitation of his diocese, and the ceremony of confirmation, which he performed in a great number of places; he also preached in several churches, sometimes twice a-day. The affairs of his parish of St James's being likewise in great disorder, he took extraordinary pains to regulate and adjust every thing, particularly the management of the poor; and thus even in a temporal view became of signal service to his parishioners. But, say our authors, "it was their spiritual welfare which engaged, as it ought to do, his chief attention. As far as the circumstances of the times, and the populousness of that part of the metropolis allowed, he omitted not even those private admonitions and personal applications which are often attended with the happiest effects. He allowed out of his own income a salary for reading early and late prayers, which had formerly been paid out of the offertory money. He held a confirmation once every year, examined the candidates several weeks before in the vestry, and gave them religious tracts, which he also distributed at other times very liberally to those that needed them. He drew up, for the use of his parishioners, that admirable course of *Lectures on the Church Catechism* which hath been lately published, and not only read them once every week on the usual days, but also every Sunday evening, either at the church or one of the chapels belonging to it."

The sermons which at the same time, we are told, he set himself to compose, "were truly excellent and original. His faculties were now in their full vigour, and he had an audience to speak before that rendered the utmost exertion of them necessary. He did not, however, seek to gratify the higher part, by amusing them with refined speculations, or ingenious essays, unintelligible to the lower part, and unprofitable to both; but he laid before them all, with equal freedom and plainness, the great Christian duties belonging to their respective stations, and reproved the follies and vices of every rank among them, without distinction or palliation. He studied human nature thoroughly in all its various forms, and knew what sort of arguments would have most weight with each class of men. He brought the subject home to their bosoms, and did not seem to be merely saying useful things in their presence, but addressing himself personally to every one of them. Few ever possessed, in a higher degree, the rare talent of touching on the most delicate subjects with the nicest propriety and decorum, of saying the most familiar things without being low, the plainest without being feeble, the boldest without giving offence. He could descend with such singular ease and felicity into the minutest concerns of common life, could lay open with so much address the various workings, artifices, and evasions of the human mind, that his audience often thought their own particular cases alluded to, and heard with surprise their private sentiments and feelings, their ways of reasoning and principles of acting, exactly stated and described. His preaching was, at the same time, highly rational, and truly evangelical. He explained with perspicuity, he asserted with dignity, the peculiar characteristic doctrines of the gospel. He inculcated the utility, the necessity of them, not merely as speculative truths, but as actual instruments of moral goodness, tending to purify the hearts and regulate the lives of men; and thus, by God's gracious appointment, as well as by the inseparable connection between true faith and right practice, leading them to salvation.

"These important truths he taught with the authority, the tenderness, the familiarity, of a parent instructing his children. Though he neither possessed nor affected the artificial eloquence of an orator who wants to amuse or to mislead, yet he had that of an honest man who wants to convince, of a Christian preacher who wants to reform and to save those that hear him. Solid argument, manly sense, useful directions, short, nervous, striking sentences, awakening questions, frequent and pertinent applications of scripture; all these following each other in quick succession, and coming evidently from the speaker's heart, enforced by his elocution, his figure, his action, and above all, by the corresponding sanctity of his example, stamped conviction on the minds of his hearers, and sent them home with impressions not easy to be effaced. It will readily be imagined that with these powers he quickly became one of the most admired and popular preachers of his time."

In 1737 he succeeded to the see of Oxford, on the promotion of Dr Potter to that of Canterbury, then vacant by the death of Archbishop Wake.

In the spring of 1748, Mrs Secker died of the gout in her stomach. She was a woman of great sense and

 merit,

Secker. merit, but of a weak and sickly constitution. The bishop's affection and tenderness for her was suited to his character. In 1750, he was installed dean of St Paul's, for which he gave in exchange the rectory of St James's and his prebend of Durham. "It was no wonder (say our authors) that, after presiding over so extensive and populous a parish for upwards of 17 years, he should willingly consent to be released from a burden which began now to grow too great for his strength. When he preached his farewel sermon, the whole audience melted into tears: he was followed with the prayers and good wishes of those whom every honest man would be most ambitious to please; and there are numbers still living who retain a strong and grateful remembrance of his incessant and tender solicitude for their welfare. Having now more leisure both to prosecute his own studies and to encourage those of others, he gave Dr Church considerable assistance in his *First and Second Vindication of the Miraculous Powers*, &c. against Dr Middleton, and he was of equal use to him in his *Analysis of Lord Bolingbroke's Works*. About the same time began the late Archdeacon Sharp's controversy with the followers of Mr Hutchinson, which was carried on to the end of the year 1755." Bishop Secker, we are told, read over all Dr Sharp's papers, amounting to three volumes 8vo, and corrected and improved them throughout. But the ease which this late change of situation gave him was soon disturbed by a heavy and unexpected stroke, the loss of his three friends, Bishops Butler, Benson, and Berkeley, who were all cut off within the space of one year.

Our authors next give an account of the part which Dr Secker bore, in the house of lords, in respect to the famous repeal of the Jew bill; for which the duke of Newcastle moved, and was seconded by the Bishop, in a speech which, we are told, was remarkably well received. At length his distinguished merit prevailed over all the political obstacles to his advancement, and placed him, without any efforts or application of his own, in that important station which he had shown himself so well qualified to adorn. On the death of Archbishop Hutton, he was promoted to the see of Canterbury, and was confirmed at Bow-church, April 21. 1758; on which occasion our authors observe, that in accepting this high and burdensome station, Dr Secker acted on that principle which influenced him through life; that he sacrificed his own ease and comfort to considerations of public utility; that the mere secular advantages of grandeur were objects below his ambition; and were, as he knew and felt, but poor compensations for the anxiety and difficulties attending them. He had never once through his whole life asked preferment for himself, nor shown any unbecoming eagerness for it; and the use he made of his newly acquired dignity very clearly showed, that rank, and wealth, and power, had in no other light any charms for him, than as they enlarged the sphere of his active and industrious benevolence.

He sought out and encouraged men of real genius or extensive knowledge; he expended 300l. in arranging and improving the manuscript library at Lambeth; and observing with concern, that the library of printed books in that palace had received no additions since the time of Archbishop Tennison, he made it his business to collect books in all languages from most parts of Europe at a very great expence, with a view of supplying that chasm; which he accordingly did, by leaving them to the library at his death, and thereby rendered that collection one of the noblest and most useful in the kingdom.

All designs and institutions which tended to advance good morals and true religion, he patronized with zeal and generosity: he contributed largely to the maintenance of schools for the poor; to rebuilding or repairing parsonage houses and places of worship; and gave no less than 600l. towards erecting a chapel in the parish of Lambeth. To the society for promoting Christian knowledge he was a liberal benefactor; and to that for propagating the gospel in foreign parts, of which he was the president, he paid much attention; was constant at all the meetings of its members, even sometimes when his health would but ill permit, and superintended their deliberations with consummate prudence and temper.

Whenever any publications came to his knowledge that were manifestly calculated to corrupt good morals, or subvert the foundations of Christianity, he did his utmost to stop the circulation of them; yet the wretched authors themselves he was so far from wishing to treat with any undue rigour, that he has more than once extended his bounty to them in distress. And when their writings could not properly be suppressed (as was too often the case) by lawful authority, he engaged men of abilities to answer them, and rewarded them for their trouble. His attention was everywhere. Even the falsehoods and misrepresentation of writers in the newspapers, on religious or ecclesiastical subjects, he generally took care to have contradicted; and when they seemed likely to injure, in any material degree, the cause of virtue and religion, or the reputation of eminent and worthy men, he would sometimes take the trouble of answering them himself. One instance of this kind, which does him honour, and deserves mention, was his defence of Bishop Butler, who, in a pamphlet published in 1767, was accused of having died a Papist. The conduct which he observed towards the several divisions and denominations of Christians in this kingdom was such as showed his way of thinking to be truly liberal and catholic. The dangerous spirit of popery, indeed, he thought should always be kept under proper legal restraints, on account of its natural opposition not only to the religious but the civil rights of mankind. He therefore observed its movements with care, and exhorted his clergy to do the same, especially those who were situated in the midst of Roman Catholic families; against whose influence they were charged to be upon their guard, and were furnished with proper books or instructions for that purpose. He took all fit opportunities of combating the errors of the church of Rome in his own writings (A); and the best answers that were published to some of the late bold apologies for popery were written at his instance, and under his direction.

With

(A) See particularly his sermons on the rebellion in 1745; on the Protestant working schools in Ireland; on the 5th

Secker.

With the Diffenters his Grace was fincerely defirous of cultivating a good underftanding. He confidered them, in general, as a confcientious and valuable clafs of men. With fome of the moft eminent of them, Watts, Doddridge, Leland, Chandler, Lardner, he maintained an intercourfe of friendfhip or civility. By the moft candid and confiderate part of them he was highly reverenced and efteemed; and to fuch among them as needed help he fhowed no lefs kindnefs and liberality than to thofe of his own communion.

Nor was his concern for the Proteftant caufe confined to his own country. He was well known as the great patron and protector of it in various parts of Europe; from whence he had frequent applications for affiftance, which never failed of being favourably received. To feveral foreign Proteftants he allowed penfions, to others he gave occafional relief, and to fome of their univerfities was an annual benefactor.

In public affairs, his Grace acted the part of an honeft citizen, and a worthy member of the Britifh legiflature. From his firft entrance into the houfe of peers, his parliamentary conduct was uniformly upright and noble. He kept equally clear from the extremes of factious petulance and fervile dependence; never wantonly thwarting adminiftration from motives of party zeal or private pique, or perfonal attachment, or a paffion for popularity; nor yet going every length with every minifter from views of intereft or ambition. He admired and loved the conftitution of his country, and wifhed to preferve it unaltered and unimpaired. So long as a due regard to this was maintained, he thought it his duty to fupport the meafures of government; but whenever they were evidently inconfiftent with the public welfare, he oppofed them with freedom and firmnefs. Yet his oppofition was always tempered with the utmoft fidelity, refpect, and decency, to the excellent prince upon the throne; and the moft candid allowances for the unavoidable errors and infirmities even of the very beft minifters, and the peculiarly difficult fituation of thofe who govern a free and high-fpirited people. He feldom fpoke in parliament, except where the interefts of religion and virtue feemed to require it; but whenever he did, he fpoke with propriety and ftrength, and was heard with attention and deference. Though he never attached himfelf blindly to any fet of men, yet his chief political connections were with the late duke of Newcaftle and Lord Chancellor Hardwicke. To thefe he principally owed his advancement; and he had the good fortune to live long enough to fhow his gratitude to them or their defcendants.

For more than ten years, during which Dr Secker enjoyed the fee of Canterbury, he refided conftantly at his archiepifcopal houfe at Lambeth. A few months before his death, the dreadful pains he felt had compelled him to think of trying the Bath waters: but that defign was ftopped by the fatal accident which put an end to his life.

His Grace had been for many years fubject to the gout, which, in the latter part of his life, returned with more frequency and violence, and did not go off in a regular manner, but left the parts affected for a long time very weak, and was fucceeded by pains in different parts of the body. About a year and a half before he died, after a fit of the gout, he was attacked with a pain in the arm, near the fhoulder, which having continued about 12 months, a fimilar pain feized the upper and outer part of the oppofite thigh, and the arm foon became eafier. This was much more grievous than the former, as it quickly difabled him from walking, and kept him in almoft continual torment, except when he was in a reclining pofition. During this time he had two or three fits of the gout; but neither the gout nor the medicines alleviated thefe pains, which, with the want of exercife, brought him into a general bad habit of body.

On Saturday July 30. 1768, he was feized, as he fat at dinner, with a ficknefs at his ftomach. He recovered before night; but the next evening, while his phyficians were attending, and his fervants raifing him on his couch, he fuddenly cried out that his thigh-bone was broken. The fhock was fo violent, that the fervants perceived the couch to fhake under him, and the pain fo acute and unexpected, that it overcame the firmnefs he fo remarkably poffeffed. He lay for fome time in great agonies; but when the furgeons arrived, and difcovered with certainty that the bone was broken, he was perfectly refigned, and never afterwards afked a queftion about the event. A fever foon enfued. On Tuefday he became lethargic, and continued fo till about five o'clock on Wednefday afternoon, when he expired with great calmnefs, in the 75th year of his age.

On examination, the thigh-bone was found to be carious about four inches in length, and at nearly the fame diftance from its head. The difeafe took its rife from the internal part of the bone, and had fo entirely deftroyed its fubftance, that nothing remained at the part where it was broken but a portion of its outward integument; and even this had many perforations, one of which was large enough to admit two fingers, and was filled with a fungous fubftance arifing from within the bone. There was no appearance of matter about the caries, and the furrounding parts were in a found ftate. It was apparent that the torture which he underwent during the gradual corrofion of this bone muft have been inexpreffibly great. Out of tendernefs to his family he feldom made any complaints to them, but to his phyficians he frequently declared his pains were fo excruciating, that unlefs fome relief could be procured he thought it would be impoffible for human nature to fupport them long. Yet he bore them for upwards of fix months with aftonifhing patience and fortitude; fat up generally the greater part of the day, admitted his particular friends to fee him, mixed with his family at the ufual hours, fometimes with his ufual cheerfulnefs; and, except fome very flight defects of memory, retained all his faculties and fenfes in their full vigour till within a few days of his death. He was buried, purfuant

5th of November; and a great number of occafional paffages to the fame purpofe, in various parts of his lectures, fermons, and other works.

ſuant to his own directions, in a covered paſſage, leading from a private door of the palace to the north door of Lambeth church; and he forbade any monument or epitaph to be placed over him.

By his will he appointed the Rev. Dr Daniel Burton, canon of Chriſt-church, and Mrs Catherine Talbot, already mentioned in the courſe of theſe memoirs, his executors; and left 13,000l. in truſt to the Drs Porteous and Stinton, his chaplains; to pay the intereſt thereof to Mrs Talbot and her daughter during their joint lives, or the life of the ſurvivor; and after the deceaſe of both thoſe ladies, 11,000l. of the ſaid 13,000l. are to be transferred to charitable purpoſes; amongſt which are 1000l. to the Society for the Propagation of the Goſpel, and 1000l. to the ſame ſociety for a biſhop or biſhops in the king's dominions in America.

The following deſcription is given of his perſon: He was tall and comely; in the early part of his life ſlender, and rather conſumptive; but as he advanced in years his conſtitution gained ſtrength, and his ſize increaſed, yet never to a degree of corpulency that was diſproportionate or troubleſome.

The dignity of his form correſponded with the greatneſs of his mind, and inſpired at all times reſpect and awe; but peculiarly ſo when he was engaged in any of the more ſolemn functions of religion, into which he entered with ſuch devout earneſtneſs and warmth, with ſo juſt a conſciouſneſs of the place he was in, and the buſineſs he was about, as ſeemed to raiſe him above himſelf, and added new life and ſpirit to the natural gracefulneſs of his appearance.

His countenance was open, ingenious, and expreſſive of every thing right. It varied eaſily with his ſpirits and his feelings, ſo as to be a faithful interpreter of his mind, which was incapable of the leaſt diſſimulation. It could ſpeak dejection, and, on occaſion, anger, very ſtrongly; but when it meant to ſhow pleaſure or approbation, it ſoftened into a moſt gracious ſmile, and diffuſed over all his features the moſt benevolent and reviving complacency that can be imagined.

SECOND, in *Geometry*, *Chronology*, &c. the 60th part of a prime or minute, whether of a degree or of an hour.

SECOND, in *Muſic*, one of the muſical intervals; being only the difference between any ſound and the next neareſt ſound, whether above or below it.

SECOND Major, in *Muſic*. See INTERVAL.

SECOND Minor, in *Muſic*. See INTERVAL.

SECOND Sight, in Erſe called *Taiſch*, is a mode of ſeeing ſuperadded to that which nature generally beſtows. This gift or faculty, which is neither voluntary nor conſtant, is in general rather troubleſome than agreeable to the poſſeſſors of it, who are chiefly found among the inhabitants of the Highlands of Scotland, thoſe of the Weſtern iſles, of the iſle of Man, and of Ireland. It is an impreſſion made either by the mind upon the eye, or by the eye upon the mind, by which things diſtant or future are perceived, and ſeen as if they were preſent. A man on a journey far from home falls from his horſe; another, who is perhaps at work about the houſe, ſees him bleeding on the ground, commonly with a landſcape of the place where the accident befals him. Another ſeer, driving home his cattle, or wandering in idleneſs, or muſing in the ſunſhine, is ſuddenly ſurpriſed by the appearance of a bridal ceremony, or funeral proceſſion, and counts the mourners or attendants, of whom, if he knows them, he relates the names; if he knows them not, he can deſcribe the dreſſes. Things diſtant are ſeen at the inſtant they happen.

Of things future, Johnſon ſays that he knows no rule pretended to for determining the time between the ſight and the event; but we are informed by Mr Groſe, that in general the time of accompliſhment bears ſome relation to the time of the day in which the impreſſions are received. Thus viſions ſeen early in the morning (which ſeldom happens) will be much ſooner accompliſhed than thoſe appearing at noon; and thoſe ſeen at noon will take place in a much ſhorter time than thoſe happening at night; ſometimes the accompliſhment of the laſt does not fall out within a year or more.

Theſe viſions are not confined to ſolemn or important events; nor is it true, as is commonly reported, that to the ſecond ſight nothing is preſented but phantoms of evil. The future viſit of a mountebank, or piper; a plentiful draught of fiſh; the arrival of common travellers; or, if poſſible, ſtill more trifling matters than theſe, —are foreſeen by the ſeers. A gentleman told Dr Johnſon, that when he had once gone far from his own iſland, one of his labouring ſervants predicted his return, and deſcribed the livery of his attendant, which he had never worn at home; and which had been, without any previous deſign, occaſionally given him.

As many men eminent for ſcience and literature have admitted the reality of this apparently uſeleſs gift, we ſhall, without interpoſing our own opinion, give the reflections of two of the firſt characters of the age upon it, and leave our readers to form their own judgment. By Dr Beattie of Aberdeen it is thus accounted for.

The Highlands of Scotland are a pictureſque but a melancholy country. Long tracts of mountainous deſert, covered with dark heath, and often obſcured by miſty weather; narrow valleys, thinly inhabited, and bounded by precipices reſounding with the fall of torrents; a ſoil ſo rugged, and a climate ſo dreary, as in many parts to admit neither the amuſements of paſturage nor the labours of agriculture; the mournful daſhing of waves along the friths and lakes that interſect the country; the portentous noiſes which every change of the wind and every increaſed diminution of the waters is apt to raiſe in a lonely region full of echoes and rocks and caverns; the groteſque and ghaſtly appearance of ſuch a landſcape by the light of the moon: objects like theſe diffuſe a gloom over the fancy, which may be compatible enough with occaſional and ſocial merriment, but cannot fail to tincture the thoughts of a native in the hour of ſilence and ſolitude. If theſe people, notwithſtanding their reformation in religion, and more frequent intercourſe with ſtrangers, do ſtill retain many of their old ſuperſtitions, we need not doubt but in former times they muſt have been much more enſlaved to the horrors of imagination, when beſet with the bugbears of Popery and Paganiſm. Moſt of their ſuperſtitions are of a melancholy caſt. That of *ſecond ſight*, by which ſome are ſtill ſuppoſed to be haunted, is conſidered by themſelves as a misfortune, on account of the many dreadful images it is ſaid to obtrude upon the fancy. It is ſaid that ſome of the Alpine regions do likewiſe lay claim to a ſort of ſecond ſight.

Nor

Second. Nor is it wonderful, that perfons of a lively imagination, immured in deep folitude, and furrounded with the ftupendous fcenery of clouds, precipices, and torrents, fhould dream (even when they think themfelves awake) of thofe few ftriking ideas with which their lonely lives are diverfified: of corpfes, funeral proceffions, and other fubjects of terror; or of marriages, and the arrival of ftrangers, and fuch like matters of more agreeable curiofity.

Let it be obferved alfo, that the ancient Highlanders of Scotland had hardly any other way of fupporting themfelves than by hunting, fifhing, or war; profeffions that are continually expofed to fatal accidents. And hence, no doubt, additional horrors would often haunt their folitude, and a deeper gloom overfhadow the imagination even of the hardieft native.

A fufficient evidence can hardly be found for the reality of the *fecond fight*, or at leaft of what is commonly underftood by that term. A treatife on the fubject was publifhed in the year 1762, in which many tales were told of perfons whom the author believed to have been favoured, or haunted, with thefe illuminations; but moft of the tales were trifling and ridiculous: and the whole work betrayed, on the part of the compiler, fuch extreme credulity, as could not fail to prejudice many readers againft his fyftem.

That any of thefe vifionaries are apt to be fwayed in their declarations by finifter views, we will not fay: but this may be faid with confidence, that none but ignorant people pretend to be gifted in this way. And in them it may be nothing more, perhaps, than fhort fits of fudden fleep or drowfinefs, attended with lively dreams, and arifing from fome bodily diforder, the effect of idlenefs, low fpirits, or a gloomy imagination. For it is admitted, even by the moft credulous Highlanders, that as knowledge and induftry are propagated in their country, the fecond fight difappears in proportion; and nobody ever laid claim to the faculty who was much employed in the intercourfe of focial life (A). Nor is it at all extraordinary, that one fhould have the appearance of being awake, and fhould even think one's felf fo, during thofe fits of dofing; that they fhould come on fuddenly, and while one is engaged in fome bufinefs. The fame thing happens to perfons much fatigued, or long kept awake, who frequently fall afleep for a moment, or for a long fpace, while they are ftanding, or walking, or riding on horfeback. Add but a lively dream to this flumber, and (which is the frequent effect of difeafe) take away the confcioufnefs of having been afleep, and a fuperftitious man may eafily miftake his dream for a waking vifion; which, however, is foon forgotten when no fubfequent occurrence recals it to his memory; but which, if it fhall be thought to refemble any future event, exalts the poor dreamer into a Highland prophet. This conceit makes him more recluse and more melancholy than ever; and fo feeds his difeafe, and multiplies his vifions: which, if they are not diffipated by bufinefs or fociety, may continue to haunt him as long as he lives; and which, in their progrefs through the neighbourhood, receive fome new tinctures of the marvellous from every mouth that promotes their circulation. As to the prophetical nature of this fecond fight, it cannot be admitted at all. That the Deity fhould work a miracle in order to give intimation of the frivolous things that thefe tales are made up of, the arrival of a ftranger, the nailing of a coffin, or the colour of a fuit of clothes; and that thefe intimations fhould be given for no end, and to thofe perfons only who are idle and folitary, who fpeak Gaelic, or who live among mountains and deferts—is like nothing in nature or providence that we are acquainted with, and muft therefore, unlefs it were confirmed by fatisfactory proof (which is not the cafe), be rejected as abfurd and incredible.

Thefe vifions, fuch as they are, may reafonably enough be afcribed to a diftempered fancy. And that in them, as well as in our ordinary dreams, certain appearances fhould, on fome rare occafions, refemble certain events, is to be expected from the laws of chance; and feems to have in it nothing more marvellous or fupernatural, than that the parrot, who deals out his fcurrilities at random, fhould fometimes happen to falute the paffenger by his right appellation.

To the confidence of thefe objections Dr Johnfon replies, that by prefuming to determine what is fit, and what is beneficial, they prefuppofe more knowledge of the univerfal fyftem than man has attained; and therefore depend upon principles too complicated and extenfive for our comprehenfion; and that there can be no fecurity in the confequence when the premifes are not underftood; that the fecond fight is only wonderful becaufe it is rare, for, confidered in itfelf, it involves no more difficulty than dreams, or perhaps than the regular exercife of the cogitative faculty; that a general opinion of communicative impulfes, or vifionary reprefentations, has prevailed in all ages and all nations; that particular inftances have been given with fuch evidence, as neither Bacon nor Bayle has been able to refift; that fudden impreffions, which the event has verified, have been felt by more than own or publifh them; that the fecond fight of the Hebrides implies only the local frequency of a power, which is nowhere totally unknown; and that where we are unable to decide by antecedent reafon, we muft be content to yield to the force of teftimony. By pretenfion to fecond fight, no profit was ever fought or gained. It is an involuntary affection, in which neither hope nor fear are known to have any part. Thofe who profefs to feel it do not boaft of it as a privilege, nor are confidered by others as advantageoufly diftinguifhed. They have no temptation to feign, and their hearers have no motive to encourage the impofture.

SECOND Terms, in *Algebra*, thofe where the unknown quantity has a degree of power lefs than it has in the term where it is raifed to the higheft. The art of throwing thefe fecond terms out of an equation, that is,

(A) This, however, is denied by Johnfon, who affirms that the Iflanders of all degrees, whether of rank or underftanding, univerfally admit it except the minifters, who, according to him, reject it, in confequence of a fyftem, againft conviction. He affirms, too, that in 1773, there was in the Hebrides a fecond-fighted gentleman, who complained of the terrors to which he was expofed.

is, of forming a new equation where they have no place, is one of the most ingenious and useful inventions in all algebra.

SECONDARY, in general, something that acts as second or in subordination to another.

SECONDARY or *Secundary*, an officer who acts as second or next to the chief officer. Such are the secondaries of the courts of king's bench and common pleas; the secondaries of the compters, who are next the sheriffs of London in each of the two compters; two secondaries of the pipe; secondaries to the remembrancers, &c.

SECONDARY Circles of the Ecliptic are circles of longitude of the stars; or circles which, passing through the poles of the ecliptic, are at right angles to the ecliptic. See *CIRCLES of Latitude*.

SECONDARY Qualities of Bodies. See METAPHYSICS, N° 153.

SECONDAT. See MONTESQUIEU.

SECRETARIES BIRD, the falco serpentarius and sagittarius of Linnæus, but classed by Latham under the genus VULTUR. See ORNITHOLOGY *Index*.

SECRETARY, an officer who, by his master's orders, writes letters, dispatches, and other instruments, which he renders authentic by his signet. Of these there are several kinds; as, 1. Secretaries of state, who are officers that have under their management and direction the most important affairs of the kingdom, and are obliged constantly to attend on the king: they receive and dispatch whatever comes to their hands, either from the crown, the church, the army, private grants, pardons, dispensations, &c. as likewise petitions to the sovereign, which, when read, are returned to them; all which they dispatch according to the king's direction. They have authority to commit persons for treason, and other offences against the state, as conservators of the peace at common law, or as justices of the peace throughout the kingdom. They are members of the privy-council, which is seldom or never held without one of them being present. As to the business and correspondence in all parts of this kingdom, it is managed by either of the secretaries without any distinction; but with respect to foreign affairs, the business is divided into two provinces or departments, the southern and the northern, comprehending all the kingdoms and states that have any intercourse with Great Britain; each secretary receiving all letters and addresses from, and making all dispatches to, the several princes and states comprehended in his province. Ireland and the Plantations are under the direction of the elder secretary, who has the southern province, which also comprehends, France, Italy, Switzerland, Spain, Portugal, and Turkey; the northern province includes the Low Countries, Germany, Denmark, Sweden, Poland, and Muscovy. Each of the secretaries has an apartment in all the royal houses, both for their own accommodation and their officers; they have also a table at the king's charge, or else board-wages. The two secretaries for Britain have each two under secretaries, and one chief clerk; with an uncertain number of other clerks and translators, all wholly depending on them. To the secretaries of state belong the custody of that seal properly called the *signet*, and the direction of two other offices, one called the *paper-office*, and the other the *signet-office*. In addition to these, there is a secretary for the war department, whose office must be temporary. 2. Secretary of an embassy, a person attending an ambassador, for writing dispatches relating to the negociation. There is a great difference between the secretaries of an embassy and the ambassador's secretary; the last being a domestic or menial of the ambassador, and the first a servant or minister of the prince. 3. The secretary of war, an officer of the war-office, who has two chief clerks under him, the last of which is the secretary's messenger. There are also secretaries in most of the other offices.

SECRETION, in the animal economy. See PHYSIOLOGY *Index*.

SECT, a collective term, comprehending all such as follow the doctrines and opinions of some famous divine, philosopher, &c.

SECTION, in general, denotes a part of a divided thing, or the division itself. Such, particularly, are the subdivisions of a chapter; called also *paragraphs* and *articles*: the mark of a section is §.

SECTION, in *Geometry*, denotes a side or surface of a body or figure cut off by another; or the place where lines, planes, &c. cut each other.

SECTOR, in *Geometry*, is a part of a circle comprehended between two radii and the arch: or it is a mixed triangle, formed by two radii and the arch of a circle.

SECTOR, is also a mathematical instrument, of great use in finding the proportion between quantities of the same kind: as between lines and lines, surfaces and surfaces, &c. whence the French call it the *compass of proportion*. The great advantage of the sector above the common scales, &c. is, that it is made so as to fit all radii and all scales. By the lines of chords, sines, &c. on the sector, we have lines of chords, sines, &c. to any radius betwixt the length and breadth of the sector when open. 1 Sector

The real inventor of this valuable instrument is unknown; yet of so much merit has the invention appeared, that it was claimed by Galileo, and disputed by nations.

The sector is founded on the fourth proposition of the sixth book of Euclid; where it is demonstrated, that similar triangles have their homologous sides proportional. An idea of the theory of its construction may be conceived thus. Let the lines AB, AC (Plate CCCCLXXVIII. fig. 1.) represent the legs of the sector; and AD, AE, two equal sections from the centre: if, now the points CB and DE be connected, the lines CB and DE will be parallel; therefore the triangles ADE, ACB will be similar; and consequently the sides AD, DE, AB, and BC, proportional; that is, as AD : DE : : AB : BC : whence, if AD be the half, third, or fourth part of AB; DE will be a half, third, or fourth part of CB: and the same holds of all the rest. If, therefore, AD be the chord, sine, or tangent, of any number of degrees to the radius AB; DE will be the same to the radius BC. Plate cccclxxviii. Fig. 1.

Description of the Sector. The instrument consists of two rules or legs, of brass or ivory, or any other matter, representing the radii, moveable round an axis or joint, the middle of which expresses the centre; whence are drawn on the faces of the rulers several scales, which may be distinguished into single and double. 2 described.

The double scales, or lines graduated upon the faces of Fig. 3. & 4.

of the inſtrument, and which are to be uſed as ſectoral lines, proceed from the centre; and are, 1. Two ſcales of equal parts, one on each leg, marked LIN. or L.; each of theſe ſcales, from the great extenſiveneſs of its uſe, is called the *line of lines*. 2. Two lines of chords marked CHO. or C. 3. Two lines of ſecants marked SEC. or S. A line of polygons marked POL. Upon the other face the ſectoral lines are, 1. Two lines of ſines marked SIN. or S. 2. Two lines of tangents marked TAN. or T. 3. Between the line of tangents and ſines there is another line of tangents to a leſſer radius, to ſupply the defect of the former, and extending from 45° to 75°, marked *t*.

Each pair of theſe lines (except the line of polygons) is ſo adjuſted as to make equal angles at the centre; and conſequently at whatever diſtance the ſector be opened, the angles will be always reſpectively equal. That is, the diſtance between 10 and 10 on the line of lines, will be equal to 60 and 60 on the line of chords, 90 and 90 on the line of ſines, and 45 and 45 on the line of tangents.

Beſides the ſectoral ſcales, there are others on each face, placed parallel to the outward edges, and uſed as thoſe of the common plane ſcale. 1. There are a line of inches. 2. A line of latitudes. 3. A line of hours. 4. A line of inclination of meridians. 5. A line of chords. Three logarithmic ſcales, namely, one of numbers, one of ſines, and one of tangents. Theſe are uſed when the ſector is fully opened, the legs forming one line (A).

3 To read and eſtimate the diviſions on the ſector and lines.

The value of the diviſions on moſt of the lines are determined by the figures adjacent to them; theſe proceed by tens, which conſtitute the diviſions of the firſt order, and are numbered accordingly; but the value of the diviſions on the line of lines, that are diſtinguiſhed by figures, is entirely arbitrary, and may repreſent any value that is given to them; hence the figures, 1, 2, 3, 4, &c. may denote either 10, 20, 30, 40, or 100, 200, 300, 400, and ſo on.

The line of lines is divided into ten equal parts, numbered 1, 2, 3, to 10; theſe may be called *diviſions of the firſt order*; each of theſe is again ſubdivided into 10 other equal parts, which may be called *diviſions of the ſecond order*; each of theſe is divided into two equal parts, forming *diviſions of the third order*. The diviſions on all the ſcales are contained between four parallel lines; thoſe of the third order extend to the moſt diſtant; thoſe of the third to the leaſt; thoſe of the ſecond to the intermediate parallel.

When the whole line of lines repreſents 100, the diviſions of the firſt order, or thoſe to which the figures are annexed, repreſent tens; thoſe of the ſecond order units; thoſe of the third order the halves of theſe units. If the whole line repreſent ten, then the diviſions of the firſt order are units; thoſe of the ſecond tenths; the thirds twentieths.

In the line of tangents, the diviſions to which the numbers are affixed, are the degrees expreſſed by thoſe numbers. Every fifth degree is denoted by a line ſomewhat longer than the reſt; between every number and each fifth degree, there are four diviſions longer than the intermediate adjacent ones, theſe are whole degrees; the ſhorter ones, or thoſe of the third order, are 30 minutes.

From the centre, to 60 degrees, the line of ſines is divided like the line of tangents, from 60 to 70; it is divided only to every degree, from 70 to 80, to every two degrees, from 80 to 90; the diviſion muſt be eſtimated by the eye.

The diviſions on the line of chords are to be eſtimated in the ſame manner as the tangents.

The leſſer line of tangents is graduated every two degrees, from 45 to 50; but from 50 to 60 to every degree; from 60 to the end, to half degrees.

The line of ſecants from 0 to 10 is to be eſtimated by the eye; from 20 to 50, it is divided to every two degrees; from 50 to 60, to every degree; from 60 to the end, to every half degree.

Uſe of the Line of Equal Parts on the SECTOR. 1. To divide a given line into any number of equal parts, ſuppoſe ſeven. Take the given line in your compaſſes; and ſetting one foot in a diviſion of equal parts, that may be divided by ſeven, for example 70, whoſe ſeventh part is 10, open the ſector till the other point fall exactly on 70, in the ſame line on the other leg. In this diſpoſition, applying one point of the compaſſes to 10 in the ſame line; ſhut them till the other fall in 10 in the ſame line on the other leg, and this opening will be the ſeventh part of the given line. Note, if the line to be divided be too long to be applied to the legs of the ſector, divide only one half or one fourth by ſeven, and the double or quadruple thereof will be the ſeventh part of the whole. 4 Diviſion of a given line by the line of equal parts.

2. To meaſure the lines of the perimeter of a polygon, one of which contains a given number of equal parts. Take the given line in your compaſſes, and ſet it parallel, upon the line of equal parts, to the number on each leg expreſſing its length. The ſector remaining thus, ſet off the length of each of the other lines parallel to the former, and the number each of them falls on will expreſs its length. 5 To meaſure the perimeter of a polygon.

3. A right line being given, and the number of parts it contains, ſuppoſe 120, to take from it a ſhorter line, containing any number of the ſame parts, ſuppoſe 25. Take the given line in your compaſſes, open the ſector till the two feet fall on 120 on each leg; then will the diſtance between 25 on one leg, and the ſame number on the other, give the line required. 6 Subtraction.

4. To multiply by the line of equal parts on the ſector. Take the lateral diſtance from the centre of the line to the given multiplicator; open the ſector till you fit that lateral diſtance to the parallel of 1 and 1, or 10 and 10, and keep the ſector in that diſpoſition; then take in the compaſſes the parallel diſtance of the multiplicand, which diſtance, meaſured laterally on the ſame line, will give the product required. Thus, ſuppoſe it were required to find the product of 8 multiplied by 4: take the lateral diſtance from the centre of the line to 4 in your compaſſes, i. e. place one foot of the compaſſes in the beginning of the diviſions, and extend the other along the line to 4. Open the ſector till you fit this lateral diſtance to the parallel of 1 and 1, or 7 Multiplication.

(A) The lines are placed in different orders on different ſectors, but they may eaſily be found by theſe general directions.

1, or 10 and 10. Then take the parallel diſtance of 8, the multiplicand; i. e. extend the compaſſes from 8, in this line, on one leg, to 8 in the ſame line on the other; and that extent, meaſured laterally, will give the product required.

8 Diviſion in general.

5. To divide by the line of equal parts on the ſector. Extend the compaſſes laterally from the beginning of the line to 1, and open the ſector till you fit that extent to the parallel of the diviſor; then take the parallel diſtance of the dividend, which extent, meaſured in a lateral direction, will give the quotient required. Thus, ſuppoſe it was required to divide 36 by 4: extend the compaſſes laterally, the beginning of the line to 1, and fit to that extent the parallel of 4, the diviſor; then extend the compaſſes parallel, from 36 on one leg to 36 on the other, and that extent, meaſured laterally, will give 9, the quotient required.

9 Proportion.

6. Proportion by the line of equal parts. Make the lateral diſtance of the ſecond term the parallel diſtance of the firſt term, the parallel diſtance of the third term is the fourth proportional. *Example.* To find a fourth proportional to 8, 4, and 6, take the lateral diſtance of 4, and make it the parallel diſtance of 8; then the parallel diſtance of 6, extended from the centre, ſhall reach to the fourth proportional 3.

In the ſame manner, a third proportional is found to two numbers. Thus, to find a third proportional to 8 and 4, the ſector remaining as in the former example, the parallel diſtance of 4, extended from the centre, ſhall reach to the third proportional 2. In all theſe caſes, if the number to be made a parallel diſtance be too great for the ſector, ſome aliquot part of it is to be taken, and the anſwer is to be multiplied by the number by which the firſt number was divided.

10 Line of chords.

Uſe of the Line of Chords on the SECTOR. 1. To open the ſector ſo as the two lines of chords may make an angle or number of degrees, ſuppoſe 40. Take the diſtance from the joint to 40, the number of the degrees propoſed, on the line of chords; open the ſector till the diſtance from 60 to 60, on each leg, be equal to the given diſtance of 40; then will the two lines on the ſector form an angle of 40 degrees, as was required.

2. The ſector being opened, to find the degrees of its aperture. Take the extent from 60 to 60, and lay it off on the line of chords from the centre; the number whereon it terminates will ſhow the degrees, &c. required.

3. To lay off any number of degrees upon the circumference of a circle. Open the ſector till the diſtance between 60 and 60 be equal to the radius of the given circle; then take the parallel extent of the chord of the number of degrees on each leg of the ſector, and lay it off on the circumference of the given circle.—Hence any regular polygon may be eaſily inſcribed in a given circle.

11 Line of polygons.

Uſe of the Line of Polygons on the SECTOR. 1. To inſcribe a regular polygon in a given circle. Take the ſemidiameter of the given circle in the compaſſes, and adjuſt it to the number 6, on the line of polygons, on each leg of the ſector: then, the ſector remaining thus opened, take the diſtance of the two equal numbers, expreſſing the number of ſides the polygon is to have; *e. gr.* the diſtance from 5 to 5 for a pentagon, from 7 to 7 for a heptagon, &c. Theſe diſtances carried about the circumference of the circle, will divide it into ſo many equal parts.

2. To deſcribe a regular polygon, *e. gr.* a pentagon, on a given right line. Take the length of the line in the compaſſes, and apply it to the extent of the number 5, 5, on the lines of polygons. The ſector thus opened, upon the ſame lines take the extent from 6 to 6; this will be the ſemidiameter of the circle the polygon is to be inſcribed in. If then, with this diſtance, from the ends of the given line, you deſcribe two arches of a circle, their interſection will be the centre of the circle.

3. On a right line, to deſcribe an iſoceles triangle, having the angles at the baſe double that at the vertex. Open the ſector, till the ends of the given line fall on 10 and 10 on each leg; then take the diſtance from 6 to 6. This will be the length of the two equal ſides of the triangle.

Uſe of the Lines of Sines, Tangents, and Secants, on the SECTOR. By the ſeveral lines diſpoſed on the ſector, we have ſcales to ſeveral radii; ſo that having a length or radius given, not exceeding the length of the ſector when opened, we find the chord, ſine, &c. thereto: *e. gr.* Suppoſe the chord, ſine, or tangent of 10 degrees, to a radius of 3 inches required; make 3 inches the aperture between 60 and 60, on the lines of chords of the two legs; then will the ſame extent reach from 45 to 45 on the line of tangents, and from 90 to 90 on the line of the ſines on the other ſide; ſo that to whatever radius the line of chords is ſet, to the ſame are all the others ſet. In this diſpoſition, therefore, if the aperture between 10 and 10, on the lines of chords, be taken with the compaſſes, it will give the chord of 10 degrees. If the aperture of 10 and 10 be in like manner taken on the lines of ſines, it will be the ſine of 10 degrees. Laſtly, if the aperture of 10 and 10 be in like manner taken on the lines of tangents, it gives the tangent of 10 degrees.

12 Sines, tangents, and ſecants.

If the chord, or tangent, of 70 degrees were required; for the chord, the aperture of half the arch, viz. 35, muſt be taken, as before; which diſtance, repeated twice, gives the chord of 70 degrees. To find the tangent of 70 degrees to the ſame radius, the ſmall line of tangents muſt be uſed, the other only reaching to 45: making, therefore, 3 inches the aperture between 45 and 45 on the ſmall line; the extent between 70 and 70 degrees on the ſame, will be the tangent of 70 degrees to 3 inches radius.

To find the ſecant of an arch, make the given radius the aperture between 0 and 0 on the lines of ſecants: then will the aperture of 10 and 10, or 70 and 70, on the ſaid lines, give the tangent of 10° or 70°.

If the converſe of any of theſe things were required, that is, if the radius be required, to which a given line is the ſine, tangent, or ſecant, it is but making the given line, if a chord, the aperture on the line of chords between 10 and 10, and then the ſector will ſtand at the radius required; that is, the aperture between 60 and 60 on the ſaid line is the radius. If the given line were a ſine, tangent, or ſecant, it is but making it the aperture of the given number of degrees; then will the diſtance of 90 and 90 on the ſines, of 45 and 45 on the tangents, of 0 and 0 on the ſecants, be the radius.

SECTOR *of an Ellipſe, of an Hyperbola, &c.* is a part reſembling

resembling the circular sector, being contained by three lines, two of which are radii, or lines drawn from the centre of the figure to the curve, and the intercepted arc or part of that curve.

SECTOR of a Sphere, is the solid generated by the revolution of the sector of a circle about one of its radii; the other radius describing the surface of a cone, and the circular arc a circular portion of the surface of the sphere of the same radius. So that the spherical sector consists of a right cone, and of a segment of the sphere having the same common base with the cone. Hence the solid content of it will be found by multiplying the base or spherical surface by the radius of the sphere, and taking one third of the product.

Astronomical SECTOR. See *ASTRONOMICAL Sector.*

Dialing SECTOR. See DIALING.

SECULAR, that which relates to affairs of the present world, in which sense the word stands opposed to *spiritual, ecclesiastical:* thus we say secular power, &c.

SECULAR, is more peculiarly used for a person who lives at liberty in the world, not shut up in a monastery, nor bound by vows, or subjected to the particular rules of any religious community; in which sense it stands opposed to *regular*. The Romish clergy are divided into secular and regular, of which the latter are bound by monastic rules, the former not.

SECULAR Games, in antiquity, solemn games held among the Romans once in an age. These games lasted three days and as many nights; during which time sacrifices were performed, theatrical shews exhibited, with combats, sports, &c. in the circus. The occasion of these games, according to Valerius Maximus, was to stop the progress of a plague. Valerius Publicola was the first who celebrated them at Rome in the year of the city 245. The solemnity was as follows: The whole world was invited by a herald to a feast which they had never seen already, nor ever should see again. Some days before the games began, the quindecemviri in the Capitol and the Palatine temple, distributed to the people purifying compositions, of various kinds, as flambeaus, sulphur, &c. From hence the populace passed to Diana's temple on the Aventine mount, with wheat, barley, and oats, as an offering. After this, whole nights were spent in devotion to the Destinies. When the time of the games was fully come, the people assembled in the Campus Martius, and sacrificed to Jupiter, Juno, Apollo, Latona, Diana, the Parcæ, Ceres, Pluto, and Proserpine. On the first night of the feast the emperor, with the quindecemviri, caused three altars to be erected on the banks of the Tiber, which they sprinkled with the blood of three lambs, and then proceeded to regular sacrifice. A space was next marked out for a theatre, which was illuminated with innumerable flambeaus and fires. Here they sung hymns, and celebrated all kinds of sports. On the day after, having offered victims at the Capitol, they went to the Campus Martius, and celebrated sports to the honour of Apollo and Diana. These lasted till next day, when the noble matrons, at the hour appointed by the oracle, went to the Capitol to sing hymns to Jupiter. On the third day, which concluded the solemnity, twenty seven boys, and as many girls, sung in the temple of Palatine Apollo hymns and verses in Greek and Latin, to recommend the city to the protection of those deities whom they designed particularly to honour by their sacrifices.

The inimitable Carmen Seculare of Horace was composed for this last day, in the Secular Games, held by Augustus.

It has been much disputed whether these games were held every hundred, or every hundred and ten years. Valerius Antius, Varro, and Livy, are quoted in support of the former opinion: In favour of the latter may be produced the quindecemviral registers, the edicts of Augustus, and the words of Horace in the Secular poem,

Cætus undenos decies per annos.

It was a general belief, that the girls who bore a part in the song should be soonest married; and that the children who did not dance and sing at the coming of Apollo, should die unmarried, and at an early period of life.

SECULAR Poem, a poem sung or rehearsed at the secular games; of which kind we have a very fine piece among the works of Horace, being a sapphic ode at the end of his epodes.

SECULARIZATION, the act of converting a regular person, place, or benefice, into a secular one. Almost all the cathedral churches were anciently regular, that is, the canons were to be religious; but they have been since secularized. For the secularization of a regular church, there is required the authority of the pope, that of the prince, the bishop of the place, the patron, and even the consent of the people. Religious that want to be released from their vow, obtain briefs of secularization from the pope.

SECUNDINES, in *Anatomy*, the several coats or membranes wherein the fœtus is wrapped up in the mother's womb; as the chorion and amnios, with the placenta, &c.

SECUNDUS, JOANNES NICOLAIUS, an elegant writer of Latin poetry, was born at the Hague in the year 1511. His descent was from an ancient and honourable family in the Netherlands; and his father Nicolaus Everardus, who was born in the neighbourhood of Middleburg, seems to have been high in the favour of the emperor Charles V. as he was employed by that monarch in several stations of considerable importance. We find him first a member of the grand parliament or council of Mechelen, afterwards president of the states of Holland and Zealand at the Hague, and lastly holding a similar office at Mechelen, where he died, August 5. 1532, aged 70.

These various employments did not occupy the whole of Everardus's time. Notwithstanding the multiplicity of his business, he found leisure to cultivate letters with great success, and even to act as preceptor to his own children, who were five sons and three daughters. They all took the name of Nicolaii from their father; but on what account our author was called *Secundus* is not known. It could not be from the order of his birth, for he was the youngest son. Perhaps the name was not given him till he became eminent; and then, according to the fashion of the age, it might have its rise from some pun, such as his being *Poetarum nemini Secundus*. Poetry, however, was by no means the profession which his father wished him to follow. He intended him for the law, and when he could no longer direct his studies himself, placed him under the care of

Jacobus Valeardus. This man is faid to have been every way well qualified to difcharge the important truft which was committed to him; and he certainly gained the affection of his pupil, who, in one of his poems, mentions the death of Valeardus with every apppearance of unfeigned forrow. Another tutor was foon provided; but it does not appear that Secundus devoted much of his time to legal purfuits. Poetry and the fifter arts of painting and fculpture had engaged his mind at a very early period; and the imagination, on which thefe have laid hold, can with difficulty fubmit to the dry ftudy of mufty civilians. Secundus is faid to have written verfes when but ten years old; and from the vaft quantity which he left behind him, we have reafon to conclude that fuch writing was his principal employment. He found time, however, to carve figures of all his own family, of his miftreffes, of the emperor Charles V. of feveral eminent perfonages of thofe times, and of many of his intimate friends; and in the laft edition of his works publifhed by Scriverius at Leyden, 1631, there is a print of one of his miftreffes with this inicription round it; VATIS AMATORIS JULIA SCULPTA MANU.

Secundus having nearly attained the age of twenty-one, and being determined, as it would feem, to comply as far as poffible with the wifhes of his father, quitted Mechelen, and went to France, where at *Bourges*, a city in the *Orleanois*, he ftudied the civil law under the celebrated *Andreas Alciatus*. Alciatus was one of the moft learned civilians of that age; but what undoubtedly endeared him much more to our author was his general acquaintance with polite literature, and more particularly his tafte in poetry. Having ftudied a year under this eminent profeffor, and taken his degrees, Secundus returned to Mechelen, where he remained only a very few months. In 1533 he went into Spain with warm recommendations to the count of Naffau and other perfons of high rank; and foon afterwards became fecretary to the cardinal archbifhop of Toledo in a department of bufinefs which required no other qualifications than what he poffeffed in a very eminent degree, a facility in writing with elegance the Latin language. It was during his refidence with this cardinal that he wrote his *Bafia*, a feries of wanton poems, of which the fifth, feventh, and ninth *carmina* of *Catullus* feem to have given the hint. Secundus was not, however, a fervile imitator of Catullus. His expreffions feem to be borrowed rather from *Tibullus* and *Propertius*; and in the warmth of his defcriptions he furpaffes every thing that has been written on fimilar fubjects by *Catullus*, *Tibullus*, *Propertius*, *C. Gallus*, *Ovid*, or *Horace*.

In 1535 he accompanied the emperor Charles V. to the fiege of Tunis, but gained no laurels as a foldier. The hardfhips which were endured at that memorable fiege were but little fuited to the foft difpofition of a votary of Venus and the mufes; and upon an enterprife which might have furnifhed ample matter for an epic poem, it is remarkable that Secundus wrote nothing which has been deemed worthy of prefervation. Having returned from his martial expedition, he was fent by the cardinal to Rome to congratulate the pope upon the fuccefs of the emperor's arms; but was taken fo ill on the road, that he was not able to complete his journey. He was advifed to feek, without a moment's delay, the benefit of his native air; and that happily recovered him.

Having now quitted the fervice of the archbifhop of Toledo, Secundus was employed in the fame office of fecretary by the bifhop of Utrecht; and fo much had he hitherto diftinguifhed himfelf by the claffical elegance of his compofitions, that he was foon called upon to fill the important poft of private Latin fecretary to the emperor, who was then in Italy. This was the moft honourable office to which our author was ever appointed; but before he could enter upon it death put a ftop to his career of glory. Having arrived at *Saint Amnnd* in the diftrict of *Tournny*, in order to meet, upon bufinefs, with the bifhop of Utrecht, he was on the 8th of October 1536 cut off by a violent fever, in the very flower of his age, not having quite completed his twenty-fifth year. He was interred in the church of the Benedictines, of which his patron, the bifhop, was *abbot* or *pro-abbot*; and his near relations erected to his memory a marble monument, with a plain Latin infcription.

The works of Secundus have gone through feveral editions, of which the beft and moft copious is that of Scriverius already mentioned. It confifts of JULIA, *Eleg.* lib. i.; AMORES, *Eleg.* lib. ii.; AD DIVERSOS *Eleg.* lib. iii.; BASIA, ftyled by the editor *incomparabilis et divinus prorfus liber*; EPIGRAMMATA; ODARUM *liber unus*; EPISTOLARUM *liber unus Elegiaca*; EPISTOLARUM *liber alter*, *heroico carmine fcriptus*; FUNERUM *liber unus*; SYLVÆ *et* CARMINUM *fragmenta*; POEMATA *nonnulla fratrum*; ITINERARIA *Secundi tria*, &c.; EPISTOLÆ *totidem*, *foluta oratione*. Of thefe works it would be fuperfluous in us to give any character after the ample teftimonies prefixed to them of *Lelius Greg. Gyraldus*, the elder *Scaliger*, *Theodore Beza*, and others equally celebrated in the republic of letters, who all fpeak of them with rapture. A French critic, indeed, after having affirmed that the genius of Secundus never produced any thing which was not excellent in its kind, adds, with too much truth, *Mais fa mufe eft un peu trop lafcive*. For this fault our author makes the following apology in an epigram addreffed to the grammarians;

Carmina cur fpargam cunctis lafciva libellis,
 Queritis? Infulfos arceo grammaticos.
Fortia magnanimi canerem fi Cæfaris arma,
 Factave DIVORUM religiofa VIRUM:
Quot mifer exciperemque notas, patererque lituras?
 Quot ferem teneris fupplicium pueris?
At nunc uda mihi dictant cum BASIA carmen,
 Pruriet et verfu mentula multa meo:
Me leget innuptæ juvenis placiturus amicæ,
 Et placitura nova blanda puella viro:
Et quemcunque juvat lepidorum de grege vatum
 Otia feftivis ludere deliciis.
Lufibus et lætis procul hinc abfiftite, SÆVI
 GRAMMATICI, injuftas et cohibite manus.
Ne puer, ab malleis cæfus lacrymanfque leporis;
 DURAM FORTE MEIS OSSIBUS OPTET HUMUM.

SECURIDACA, a genus of plants belonging to the clafs diadelphia. See BOTANY *Index*.

SECUTORES, a fpecies of gladiators among the Romans, whofe arms were a helmet, a fhield, and a fword or a leaden bullet. They were armed in this manner, becaufe they had to contend with the retiarii, who

Secutores || Sedition.

were dreſſed in a ſhort tunic, bore a three-pointed lance in their left hand, and a net in their right. The retiarius attempted to caſt his net over the head of the ſecutor; and if he ſucceeded, he drew it together and ſlew him with his trident: but if he miſſed his aim, he immediately betook himſelf to flight till he could find a ſecond opportunity of entangling his adverſary with his net. He was purſued by the ſecutor, who endeavoured to diſpatch him in his flight.

Secutores was alſo a name given to ſuch gladiators as took the place of thoſe killed in the combat, or who engaged the conqueror. This poſt was uſually taken by lot.

SEDAN is a town in France, in the department of the Ardennes, in E. Long. 4. 45. N. Lat. 49. 46. This is the capital of a principality of the ſame name, ſituated on the Maeſe, ſix miles from Bouillon, and fifteen from Charleville. Its ſituation on the frontiers of the territory of Liege, Namur, and Limburg, formerly rendered it one of the keys of the kingdom. It is extremely well fortified, and defended by a ſtrong citadel. The caſtle is ſituated on a rock, ſurrounded with large towers and ſtrong walls; here you ſee a moſt beautiful magazine of ancient arms. The governor's palace is oppoſite the caſtle. From the ramparts you have a moſt agreeable proſpect of the Maeſe and the neighbouring country. Though the town is but ſmall, yet it is full of tradeſmen, as tanners, weavers, dyers, &c. the manufacture of fine cloth in this city employing a great number of hands. The principality of Sedan formerly belonged to the duke of Bouillon, who was obliged in the beginning of the laſt century to reſign it to the crown.

SEDAN-CHAIR is a covered vehicle for carrying a ſingle perſon, ſuſpended by two poles, and borne by two men, hence denominated *chairmen.* They were firſt introduced in London in 1634, when Sir Sanders Duncomb obtained the ſole privilege to uſe, let, and hire a number of the ſaid covered chairs for fourteen years.

SEDGMOOR, a large and rich tract of land in Somerſetſhire, memorable for the defeat of the duke of Monmouth, in 1685. It lies between Somerton and Bridgewater.

SEDITION, among civilians, is uſed for a factious commotion of the people, or an aſſembly of a number of citizens without lawful authority, tending to diſturb the peace and order of the ſociety. This offence is of different kinds: ſome ſeditions more immediately threatening the ſupreme power, and the ſubverſion of the preſent conſtitution of the ſtate; others tending only towards the redreſs of private grievances. Among the Romans, therefore, it was variouſly puniſhed, according as its end and tendency threatened greater miſchief. See lib. i. *Cod. de Seditioſis*, and *Mat. de Crimin.* lib. ii. n. 5. *de Læſa Majeſtate.* In the puniſhment, the authors and ringleaders were juſtly diſtinguiſhed from thoſe who, with leſs wicked intention, joined and made part of the multitude.

The ſame diſtinction holds in the law of England and in that of Scotland. Some kinds of ſedition in England amount to high treaſon, and come within the ſtat. 25 Edw. III. as levying war againſt the king. And ſeveral ſeditions are mentioned in the Scotch acts of parliament as treaſonable. *Bayne's Crim. Law of Scotland*, p. 33, 34. The law of Scotland makes riotous and tumultuous aſſemblies a ſpecies of ſedition. But the law there, as well as in England, is now chiefly regulated by the riot act, made 1 Geo. I. only it is to be obſerved, that the proper officers in Scotland, to make the proclamation thereby enacted, are ſheriffs, ſtewards, and bailies of regalities, or their deputies; magiſtrates of royal boroughs, and all other inferior judges and magiſtrates; high and petty conſtables, or other officers of the peace, in any county, ſtewartry, city, or town. And in that part of the iſland, the puniſhment of the offence is any thing ſhort of death which the judges, in their diſcretion, may appoint.

Sedition || Sedley.

SEDATIVES, in *Medicine*, a general name for ſuch medicines as weaken the powers of nature, ſuch as blood-letting, cooling ſalts, purgatives, &c.

SE-DEFENDENDO, in *Law*, a plea uſed for him that is charged with the death of another, by alleging that he was under a neceſſity of doing what he did in his own defence: as that the other aſſaulted him in ſuch a manner, that if he had not done what he did, he muſt have been in hazard of his own life. See HOMICIDE and MURDER.

SEDIMENT, the ſettlement or dregs of any thing, or that groſs heavy part of a fluid body which ſinks to the bottom of the veſſel when at reſt.

SEDLEY, SIR CHARLES, an Engliſh poet and wit the ſon of Sir John Sedley of Aylesford in Kent, was born about the year 1639. At the reſtoration he came to London to join the general jubilee; and commenced wit, courtier, poet, and gallant. He was ſo much admired, that he became a kind of oracle among the poets; which made King Charles tell him, that Nature had given him a patent to be Apollo's viceroy. The productions of his pen were ſome plays, and ſeveral delicately tender amorous poems, in which the ſoftneſs of the verſes was ſo exquiſite, as to be called by the duke of Buckingham *Sedley's witchcraft.* "There were no marks of genius or true poetry to be deſcried, (ſay the authors of the *Biographia Britannica*); the art wholly conſiſted in raiſing looſe thoughts and lewd deſires, without giving any alarm; and ſo the poiſon worked gently and irreſiſtibly. Our author, we may be ſure, did not eſcape the infection of his own art, or rather was firſt tainted himſelf before he ſpread the infection to others."—A very ingenious writer of the preſent day, however, ſpeaks much more favourably of Sir Charles Sedley's writings. "He ſtudied human nature; and was diſtinguiſhed for the art of making himſelf agreeable, particularly to the ladies; for the verſes of Lord Rocheſter, beginning with, *Sedley has that prevailing gentle art*, &c. ſo often quoted, allude not to his *writings*, but to his *perſonal addreſs.*" [*Langhorn's Effuſions*, &c.].—But while he thus grew in reputation for wit and in favour with the king, he grew poor and debauched: his eſtate was impaired, and his morals were corrupted. One of his frolics, however, being followed by an indictment and a heavy fine, Sir Charles took a more ſerious turn, applied himſelf to buſineſs, and became a member of parliament, in which he was a frequent ſpeaker. We find him in the houſe of commons in the reign of James II. whoſe attempts upon the conſtitution he vigorouſly withſtood; and he was very active in bringing on the revolution. This was thought more extraordinary, as he had received favours from James. But that prince had taken a fancy to Sir

Charles's

Charles's daughter (though it seems she was not very handsome), and, in consequence of his intrigues with her, he created Miss Sedley countess of Dorchester. This honour, so far from pleasing, greatly shocked Sir Charles. However libertine he himself had been, yet he could not bear the thoughts of his daughter's dishonour; and with regard to her exaltation, he only considered it as rendering her more conspicuously infamous. He therefore conceived a hatred for the king; and from this, as well as other motives, readily joined to dispossess him of the throne. A witty saying of Sedley's, on this occasion, is recorded. "I hate ingratitude, (said Sir Charles); and therefore, as the king has made my daughter a countess, I will endeavour to make his daughter a queen;" meaning the princess Mary, married to the prince of Orange, who dispossessed James of the throne at the revolution. He lived to the beginning of Queen Anne's reign; and his works were printed in two vols. 8vo. 1719.

SEDR, or SEDRE, the high-priest of the sect of Ali among the Persians. The sedre is appointed by the emperor of Persia, who usually confers the dignity on his nearest relation. The jurisdiction of the sedre extends over all effects destined for pious purposes, over all mosques, hospitals, colleges, sepulchres, and monasteries. He disposes of all ecclesiastical employments, and nominates all the superiors of religious houses. His decisions in matters of religion are received as so many infallible oracles: he judges of all criminal matters in his own house without appeal. His authority is balanced by that of the mudsitehid, or first theologue of the empire.

SEDUCTION, is the act of tempting and drawing aside from the right path, and comprehends every endeavour to corrupt any individual of the human race. This is the import of the word in its largest and most general sense; but it is commonly employed to express the act of tempting a virtuous woman to part with her chastity.

The *seducer* of female innocence practises the same stratagems of fraud to get possession of a woman's person, that the *swindler* employs to get possession of his neighbour's goods or money; yet the law of honour, which pretends to abhor *deceit*, and which impels its votaries to *murder* every man who presumes, however justly, to suspect them of fraud, or to question their veracity, applauds the address of a successful intrigue, though it be well known that the seducer could not have obtained his end without swearing to the truth of a thousand falsehoods, and calling upon God to witness promises which he never meant to fulfil.

The law of honour is indeed a very capricious rule, which accommodates itself to the pleasures and conveniences of higher life; but the law of the land, which is enacted for the equal protection of high and low, may be supposed to view the guilt of seduction with a more impartial eye. Yet for this offence, even the laws of this kingdom have provided no other punishment than a pecuniary satisfaction to the injured family; which, in England, can be obtained only by one of the quaintest fictions in the world, by the father's bringing his action against the seducer for the loss of his daughter's service during her pregnancy and nurturing. See Paley's *Moral Philosophy*, Book III. Part iii. Chap. 3.

The moralist, however, who estimates the merit or demerit of actions, not by laws of human appointment, but by their general consequences as established by the laws of nature, must consider the seducer as a criminal of the deepest guilt. In every civilized country, and in many countries where civilization has made but small progress, the virtue of women is collected as it were into a single point, which they are to guard above all things, as that on which their happiness and reputation wholly depend. At first sight this may appear a capricious regulation; but a moment's reflection will convince us of the contrary. In the married state so much confidence is necessarily reposed in the fidelity of women to the beds of their husbands, and evils so great result from the violation of that fidelity, that whatever contributes in any degree to its preservation, must be agreeable to him who, in establishing the laws of nature, intended them to be subservient to the real happiness of all his creatures. But nothing contributes so much to preserve the fidelity of wives to their husbands, as the impressing upon the minds of women the highest veneration for the virtue of chastity. She who, when unmarried, has been accustomed to grant favours to different men, will not find it easy, if indeed possible, to resist afterwards the allurements of variety. It is therefore a wise institution, and agreeable to the will of Him who made us, to train up women so as that they may look upon the loss of their chastity as the most disgraceful of all crimes; as that which sinks them in the order of society, and robs them of all their value. In this light virtuous women actually look upon the loss of chastity. The importance of that virtue has been so deeply impressed upon their minds, and is so closely associated with the principle of honour, that they cannot think but with abhorrence upon the very deed by which it is lost. He therefore who by fraud and falsehood persuades the unsuspecting girl to deviate in one instance from the honour of the sex, weakens in a great degree her moral principle; and if he reconcile her to a repetition of her crime, he destroys that principle entirely, as she has been taught to consider all other virtues as inferior to that of chastity. Hence it is that the hearts of prostitutes are generally steeled against the miseries of their fellow-creatures; that they lend their aid to the seducer in his practices upon other girls; that they lie and swear and steal without compunction; and that too many of them hesitate not to commit murder if it can serve any selfish purpose of their own.

The loss of virtue, though the greatest that man or woman can sustain, is not the only injury which the seducer brings on the girl whom he deceives. She cannot at once reconcile herself to prostitution, or even to the loss of character; and while a sense of shame remains in her mind, the misery which she suffers must be exquisite. She knows that she has forfeited what in the female character is most valued by both sexes; and she must be under the perpetual dread of a discovery. She cannot even confide in the honour of her seducer, who may reveal her secret in a fit of drunkenness, and thus rob her of her fame as well as of her virtue; and while she is in this state of anxious uncertainty, the agony of her mind must be insupportable. That it is so in fact, the many instances of child murder by unmarried women of every rank leave us no room to doubt. The affection of a mother to her new-born child is one of the most unequivocal and strongest instincts in human nature

nature (see INSTINCT); and nothing short of the extremity of distress could prompt any one so far to oppose her nature as to embrue her hands in the blood of her imploring infant.

Even this deed of horror seldom prevents a detection of the mother's frailty, which is indeed commonly discovered, though no child has been the consequence of her intrigue. He who can seduce is base enough to betray; and no woman can part with her honour, and retain any well-grounded hope that her amour shall be kept secret. The villain to whom she surrendered will glory in his victory, if it was with difficulty obtained; and if she surrendered at discretion, her own behaviour will reveal her secret. Her reputation is then irretrievably lost, and no future circumspection will be of the smallest avail to recover it. She will be shunned by the virtuous part of her own sex, and treated as a mere instrument of pleasure by the other. In such circumstances she cannot expect to be married with advantage. She may perhaps be able to captivate the heart of a heedless youth, and prevail upon him to unite his fate to her's before the delirium of his passion shall give him time for reflection; she may be addressed by a man who is a stranger to her story, and married while he has no suspicion of her secret; or she may be solicited by one of a station inferior to her own, who, though acquainted with every thing that has befallen her, can barter the delicacy of wedded love for some pecuniary advantage; but from none of these marriages can she look for happiness. The delirium which prompted the first will soon vanish, and leave the husband to the bitterness of his own reflections, which can hardly fail to produce cruelty to the wife. Of the secret, to which, in the second case, the lover was a stranger, the husband will soon make a discovery, or at least find room for harbouring strong suspicions; and suspicions of having been deceived in a point so delicate have hitherto been uniformly the parents of misery. In the third case, the man married her merely for money, of which having got the possession, he has no farther inducement to treat her with respect. Such are some of the consequences of seduction, even when the person seduced has the good fortune to get afterwards a husband; but this is a fortune which few in her circumstances can reasonably expect. By far the greater part of those who have been defrauded of their virtue by the arts of the seducer sink deeper and deeper into guilt, till they become at last common prostitutes. The public is then deprived of their service as wives and parents; and instead of contributing to the population of the state, and to the sum of domestic felicity, these outcasts of society become seducers in their turn, corrupting the morals of every young man whose appetites they can inflame, and of every young woman whom they can entice to their own practices.

All this complication of evil is produced at first by arts, which, if employed to deprive a man of his property, would subject the offender to the execration of his fellow-subjects, and to an ignominious death: but while the forger of a bill is pursued with relentless rigour by the ministers of justice, and the swindler loaded with universal reproach, the man who by fraud and forgery has enticed an innocent girl to gratify his desires at the expence of her virtue, and thus introduced her into a path which must infallibly lead to her own ruin, as well as to repeated injuries to the public at large, is not despised by his own sex, and is too often caressed even by the virtuous part of the other. Yet the loss of property may be easily repaired; the loss of honour is irreparable! It is vain to plead in alleviation of this guilt, that women should be on their guard against the arts of the seducer. Most unquestionably they should; but arts have been used which hardly any degree of caution would have been sufficient to counteract. It may as well be said that the trader should be on his guard against the arts of the forger, and accept of no bill without previously consulting him in whose name it is written. Cases, indeed, occur in trade, in which this caution would be impossible; but he must be little acquainted with the workings of the human heart, who does not know that situations likewise occur in life, in which it is equally impossible for a girl of virtue and tenderness to resist the arts of the man who has completely gained her affections.

The mentioning of this circumstance leads us to consider another species of seduction, which, though not so highly criminal as the former, is yet far removed from innocence; we mean the practice which is too prevalent among young men of fortune of employing every art in their power to gain the hearts of heedless girls whom they resolve neither to marry nor to rob of their honour. Should a man adhere to the latter part of this resolution, which is more than common fortitude can always promise for itself, the injury which he does to the object of his amusement is yet very great, as he raises hopes of the most sanguine kind merely to disappoint them, and diverts her affections perhaps for ever from such men as, had they been fixed on one of them, might have rendered her completely happy. Disappointments of this kind have sometimes been fatal to the unhappy girl; and even when they have neither deprived her of life, nor disordered her reason, they have often kept her wholly from marriage, which, whatever it be to a man, is that from which every woman expects her chief happiness. We cannot therefore conclude this article more properly than with warning our female readers not to give up their hearts hastily to men whose station in life is much higher than their own; and we beg leave to assure every one of them, that the man who solicits the last favour under the most solemn promise of a subsequent marriage, is a base seducer, who prefers a momentary gratification of his own to her honour and happiness through life, and has no intention to fulfil his promise. Or, if he should by any means be compelled to fulfil it, she may depend upon much ill treatment in return for her premature compliance with his base desires.

SEDUM, ORPINE, a genus of plants belonging to the decandria class, and in the natural method ranking under the 13th order, *Succulentæ*. See BOTANY *Index*.

SEED, in *Physiology*, a substance prepared by nature for the reproduction and conservation of the species both in animals and plants. See BOTANY and PHYSIOLOGY.

SEEDLINGS, among gardeners, denote such roots of gilliflowers, &c. as come from seed sown. Also the young tender shoots of any plants that are newly sown.

SEEDS, PRESERVATION OF, in a state fit for vegetation, is a matter of great and general importance, because,

cauſe, if it be poſſible to accompliſh it, we ſhall thus be enabled to rear many uſeful plants in one country which are there unknown, being indigenous only in others at a great diſtance from it.

A gentleman informs us, that many years ago he obſerved ſome ſeeds which had got accidentally among raiſins, being ſuch as are raiſed in England with difficulty, after being ſent from abroad in the uſual manner. He ſowed them in pots within a framing; and as every one of them grew, he ſent orders to his ſons, who were at that time abroad, to pack up all kinds of ſeeds they could procure, in abſorbent paper, and ſend ſome of them ſurrounded by raiſins, and others by brown moiſt ſugar; concluding, that the preſervation of the former ſeeds had been owing to a peculiarly favourable ſtate of the moiſture thus afforded them. He likewiſe concluded that, as many of our common ſeeds, ſuch as clover, charlock, &c. would lie dormant for ages within the earth, well preſerved for vegetation whenever they were thrown to its ſurface, and expoſed to the influence of the atmoſphere, ſo likewiſe might theſe foreign ſeeds be equally preſerved, at leaſt for many months, by the kindly covering and genial moiſture afforded them by ſugar or raiſins. This opinion was fully verified, as not one in twenty of them failed to vegetate, while the ſame ſpecies of ſeeds ſent home in common parcels along with them, did not vegetate at all. Having examined them prior to their being committed to the earth, he obſerved that there was a prevailing dryneſs in the latter, while the former looked healthy and freſh, not being in the ſmalleſt degree infeſted by inſects, as was the caſe with the others. It has been repeatedly tried to convey ſeeds cloſed up in bottles, but this method has failed of ſucceſs, a larger proportion of air, as well as a proper ſtate of moiſture, perhaps being neceſſary. It may be requiſite to obſerve, that no difference was made in the package of the ſeeds, reſpecting their being kept in huſks, pods, &c. ſo as to give thoſe preſerved in raiſins or ſugar any advantage over the others, the whole being ſent equally guarded by their natural teguments*.

* *Tranſactions of the Society of Arts*, vol. xvi.

SEEDY, in the brandy trade, a term uſed by the dealers to denote a fault that is found in ſeveral parcels of French brandy, which renders them unſaleable. The French ſuppoſe that theſe brandies obtain the flavour which they expreſs by this name, from weeds that grow among the vines from whence the wine of which this brandy is preſſed was made.

SEEING, the perceiving of external objects by means of the eye. For an account of the organs of ſight, and the nature of viſion, ſee ANATOMY and OPTICS *Index*.

SEEKS, a religious ſect ſettled at Patna, and ſo called from a word contained in one of the commandments of their founder, which ſignifies *learn thou*. In books giving an account of oriental ſects and oriental cuſtoms, we find mention made both of *Seeks* and *Seiks;* and we are ſtrongly inclined to think that the ſame tribe is meant to be denominated by both words. If ſo, different authors write very differently of their principles and manners. We have already related ſomething of the character of the *Seiks* under the article HINDOOS; but in the Aſiatic Reſearches, Mr Wilkins gives a much more amiable account of the *Seeks*, which we lay before our readers with pleaſure.

The Seeks are a ſect diſtinguiſhed both from the Muſſulmans and the worſhippers of Brahma; and, from our author's account of them, muſt be an amiable people. He aſked leave to enter into their chapel: They ſaid it was a place of worſhip, open to all men, but intimated that he muſt take off his ſhoes. On complying with this ceremony, he was politely conducted into the hall, and ſeated upon a carpet in the midſt of the aſſembly. The whole building forms a ſquare of about 40 feet. The hall is in the centre, divided from four other apartments by wooden arches, upon pillars of the ſame materials. The walls above the arches were hung with European looking-glaſſes in gilt frames, and with pictures. On the left hand, as one enters, is the chancel, which is furniſhed with an altar covered with cloth of gold, raiſed a little above the ground in a declining poſition. About it were ſeveral flower-pots and roſe-water bottles, and three urns to receive the donations of the charitable. On a low deſk, near the altar, ſtood a great book, of folio ſize, from which ſome portions are daily read in the divine ſervice. When notice was given that it was *noon*, the congregation arranged themſelves upon the carpet on each ſide of the hall. The great book and deſk were brought from the altar, and placed at the oppoſite extremity. An old ſilver-haired man kneeled down before the deſk, with his face towards the altar, and by him ſat a man with a drum, and two or three with cymbals. The book was now opened, and the old man began to chant to the time of the inſtruments, and at the concluſion of every verſe moſt of the congregation joined chorus in a reſponſe, with countenances exhibiting great marks of joy. Their tones were not harſh; the time was quick; and Mr Wilkins learned that the ſubject was a hymn in praiſe of the unity, omnipreſence, and omnipotence of the Deity. The hymn concluded, the whole company got up and preſented their faces, with joined hands, towards the altar in the attitude of prayer. The prayer was a ſort of litany pronounced by a young man in a loud and diſtinct voice; the people joining, at certain periods, in a general reſponſe. This prayer was followed by a ſhort bleſſing from the old man, and an invitation to the aſſembly to partake of a friendly feaſt. A ſhare was offered to Mr Wilkins, who was too polite to refuſe it. It was a kind of ſweetmeat compoſed of ſugar and flower mixed up with clarified butter. They were next ſerved with a few ſugar plums; and thus ended the feaſt and ceremony.

In the courſe of converſation Mr Wilkins learned that the founder of this ſect was *Naneek Sah*, who lived about 400 years ago; who left behind him a book, compoſed by himſelf in verſe, containing the doctrines he had eſtabliſhed; that this book teaches, that there is but one God, filling all ſpace, and pervading all matter; and that there will be a day of retribution, when virtue will be rewarded, and vice puniſhed. (Our author forgot to aſk in what manner). It forbids murder, theft, and ſuch other deeds as are by the majority of mankind eſteemed crimes, and inculcates the practice of all the virtues; but, particularly, a univerſal philanthropy and hoſpitality to ſtrangers and travellers. It not only commands univerſal toleration, but forbids diſputes with thoſe of another perſuaſion. If any one ſhow a ſincere inclination to be admitted among them, any five or more Seeks being aſſembled in any place, even on the highway, they ſend to the firſt ſhop where ſweet-

meats

meats are fold, and procure a very fmall quantity of a particular kind called *batâfâ* (Mr Wilkins does not tell us of what it is compofed), which having diluted in pure water, they fprinkle fome of it on the body and eyes of the profelyte, whilft one of the beft inftructed repeats to him the chief canons of their faith, and exacts from him a folemn promife to abide by them the reft of his life. They offered to admit Mr Wilkins into their fociety; but he declined the honour, contenting himfelf with their alphabet, which they told him to guard as the apple of his eye, as it was a facred character. Mr Wilkins finds it but little different from the Dewanagari. The language itfelf is a mixture of Perfian, Arabic, and Shanfcrit, grafted upon the provincial dialect of Punjah, which is a kind of Hindowee, or, as we commonly call it, *Moors*.

SEGALIEN, a large ifland feparated from the coaft of Chinefe Tartary by a narrow channel. It is called Tchoka by the natives, and Oku-Jeffu by the Chinefe. It is fituated between 46° and 54° N. Lat.; but its breadth from eaft to weft is unknown. The frigates under the command of Peroufe came to anchor in different bays, to the fineft of which, in 48° 59′ N. Lat. and 140° 32′ E. Long. from Paris, the French commodore gave the name of Baie d'Eftaing.

Segalien is well wooded, and mountainous towards the centre, but flat and level along the coaft, the foil of which is peculiarly favourable to agriculture; and vegetation is extremely vigorous. The whole furface is almoft covered with forefts of pine, birch, oak, and willow trees; and the feas, rivers, and brooks, abound with excellent falmon and trout. In general, the weather is mild and foggy; and the inhabitants are healthy and ftrong, and many of them live to an extreme old age. The prefents received by the natives from the French, were only valued in proportion to their utility. They make ufe of looms, which are complete inftruments, though fmall. The inhabitants in general do not exceed five feet in height, although fome of the talleft meafure about five feet four inches. Their countenances are animated and agreeable; their cheeks are large, their nofe rounded at the extremity; they have ftrong voices, and rather thick lips, which are of a dull red.

The women are not fo tall as the men, but of a more rounded and delicate form, with dreffes nearly fimilar; their upper lip is tattoed all over of a blue colour; the hair of their head is black, fmooth, and of a moderate ftrength, worn about fix inches long behind, and they cut it into a brufh on the top of their head and over the temples. They wear furtouts of fkin or quilted nankeen, which reaches to the calf of the leg, and fometimes lower, by which the ufe of drawers is in a great meafure rendered unneceffary. They all wear girdles, like the lower orders among the Chinefe, from which a knife is fufpended as a defence againft the bears, and a number of fmall pockets for holding their flint and fteel, pipe and box of tobacco, for they are very great fmokers. Their huts are fmall in proportion to the number of inhabitants they contain, but fufficient to defend them againft the rain and other inclemencies of the atmofphere. The roof confifts of two inclined planes, from 10 to 12 feet high at their union, and three or four on the fides; the breadth of the roof is 15, and its length 18 feet. They ufe iron pots in cooking, alfo fhells, veffels made of wood and birch bark, of different forms and workmanfhip. They have two meals a-day, the one at noon, and the other in the evening. Each family has its own hunting and fifhing implements, and their arms are bows, javelins, and a kind of fpontoon, which laft is employed in hunting the bear.

The only domeftic animals are dogs, of a middling fize, with fhaggy hair, pricked ears, and a long fharp muzzle, with a loud but not favage cry.

The people of Segalien are of a mild and unfufpicious difpofition, and appear to hold a commercial intercourfe with the Chinefe through the medium of the Mantchou Tartars, with the Ruffians to the north of their ifland, and the Japanefe to the fouth; but the articles of trade confift only of a few furs and whale oil.

SEGEBERG, a town of Germany, in the duchy of Holftein, and in Wagria; with a caftle ftanding on a high mountain, confifting of limeftone, large quantities of which are carried to Hamburg and Lubeck. It belongs to Denmark, and is feated on the river Treve, in E. Long. 10. 9. N. Lat. 54. 0.

SEGEDIN, a ftrong town of Lower Hungary, in the county of Czongrad, with a caftle. The Imperialifts took it from the Turks in 1686. It is feated at the confluence of the rivers Teffe and Mafroch, in E. Long. 20. 35. N. Lat. 46. 28.

SEGMENT *of a* CIRCLE, in *Geometry*, is that part of the circle contained between a chord and an arch of the fame circle.

SEGMENTS, LINE OF, two particular lines on Gunter's fector. They lie between the lines of fines and fuperficies, and are numbered, 5, 6, 7, 8, 9, 10. They reprefent the diameter of a circle, fo divided into 100 parts, that a right line drawn through thefe parts, and perpendicular to the diameter, fhall cut the circle into two fegments, the greater of which fhall have the fame proportion to the whole circle, as the parts cut off have to 100.

SEGNA, a city of Croatia, belonging to the houfe of Auftria, and feated on the coaft of the gulf of Venice. It was formerly a place of ftrength and great importance; but it has fuffered many calamities, and its inhabitants at prefent do not amount to 7000. In the beginning of this century it fent 50 merchant fhips to fea; but the inconveniency of its fituation and badnefs of its harbour, in which the fea is never calm, difcouraged navigation, and Segna has now very few fhips belonging to it. Among the cuftoms of the Segnans, Mr Fortis mentions one relative to the dead, which for its fingularity may be worthy of notice.

"All the relations and friends of the family go to kifs the corpfe, by way of taking leave, before burial. Each of them uncovers the face, over which a handkerchief is fpread, more or lefs rich according to the family; having kiffed the dead perfon, every one throws another handkerchief over the face; all which remain to the heirs, and fometimes there are 20, 30, and more at this ceremony. Some throw all thefe handkerchiefs into the grave with the corpfe, and this, in former times, was the general cuftom; but then they were rich. This feems to have been brought into ufe as a fubftitute for the ancient *vafi lachrymatorii*." E. Long. 15. 21. N. Lat. 45. 22.

Fortis's Travels into Dalmatia.

SEGNI, an ancient town of Italy, in the Campagna of

Sego, Segovia. of Rome, with a bishop's see, and the title of duchy. It is said that organs were first invented here. It is seated on a mountain. E. Long. 13. 15. N. Lat. 41. 50.

SEGO, the metropolis of the kingdom of Bambarra in Africa, on the banks of the Niger, in N. Lat. 14. 4. and W. Long. 2. 1. It consists of four distinct towns, two on the northern bank of the river, called Sego Korro, and Sego Boo; and two on the southern bank, called Sego Soo Korro, and Sego See Korro, all surrounded with lofty mud walls, and the houses are constructed of clay, several of them two stories high, and even white-washed. Mosques are to be seen in every quarter, and the streets, though narrow, are sufficiently broad for every useful purpose, where wheel-carriages are wholly unknown. According to Mr Park, the inhabitants of Sego amount to 30,000; and it is the constant residence of the king of Bambarra, a considerable part of whose revenue arises from the fare given by passengers for crossing the river. The people, however, are not so hospitable as in many other African towns, as the Moors are here very numerous, whose bigotry renders them the implacable enemies of every white man, if suspected of being a Christian.

Mr Park being therefore prohibited from living in Sego, resided for three days in an adjacent village, and was dismissed on the fourth, after receiving 5000 kowries from the king, to enable him to buy provisions in the course of his journey; and although it amounted only to 20s. sterling, so very cheap were the necessaries of life in Bambarra, that he found it sufficient to procure provisions for himself, and corn for his horse, for not fewer than 50 days.

SEGORBE, a town of Spain, in the kingdom of Valencia, with the title of a duchy, and a bishop's see. It is seated on the side of a hill, between the mountains, in a soil very fertile in corn and wine, and where there are quarries of fine marble. It was taken from the Moors in 1245; and the Romans thought it worth their while to carry some of the marble to Rome. W. Long. 0. 3. N. Lat. 39. 48.

SEGOVIA, an ancient city of Spain, of great power in the time of the Cæsars, is built upon two hills near the banks of the Arayda in Old Castile. W. Long. 3. 48. N. Lat. 41. 0. It is still a bishop's see, and is distinguished for some venerable remains of antiquity. In the year 1525 the city contained 5000 families, but now they do not surpass 2000, a scanty population for 25 parishes; yet, beside 21 churches and a cathedral, there are 21 convents.

The first object in Segovia that attracts the eye is the aqueduct, which the singular situation of the city renders necessary. As it is built upon two hills, and the valley by which they are separated, and extends considerably in every direction, it was difficult for a part of the citizens to be supplied with water. The difficulty was removed, according to the opinion of the learned, in the reign of Trajan, by this aqueduct, which is one of the most astonishing and the best preserved of the Roman works. In the opinion of Mr Swinburne, who surveyed it in 1776, and who seems to have given a very accurate account of the curiosities of Segovia, it is superior in elegance of proportion to the Pont du Gard at Nismes. It is so perfectly well preserved, that it does not seem leaky in any part. From the first low arches to the reservoir in the town, its length is 2400 Spanish feet; its greatest height (in the Plaza del Azobejo at the foot of the walls) is 104; it is there composed of a double row of arches, built of large square stones without mortar, and over them a hollow wall of coarser materials for the channel of the water, covered with large oblong flags. Of the lower range of arcades, which are 15 feet wide by 65 high, there are 42. The upper arches are 119 in number, their height 27 Spanish feet, their breadth seventeen, the transverial thickness, or depth of the piers, eight feet.

Swinburne's Travels through Spain.

The cathedral is a mixture of the Gothic and Moorish architecture. The inside is very spacious and of majestic simplicity. The windows are well disposed, and the great altar has been lately decorated with the finest Grenadan marble. But it is to be regretted, that in this cathedral, as well as in most others of Spain, the choir is placed in the middle of the nave. The church is nearly upon the model of the great church of Salamanca, but it is not so highly finished.

Travels in Spain by the Chev. de Bourgoanne.

The alcazar, or ancient palace of the Moors, stands in one of the finest positions possible, on a rock rising above the open country. A fine river washes the foot of the precipice, and the city lies admirably well on each side on the brow of the hill; the declivity is woody, and the banks charmingly rural; the snowy mountains and dark forests of Saint Ildefonzo compose an awful back-ground to the picture. Towards the town there is a large court before the great outward tower, which, as the prison of Gil Blas, is so well described by Le Sage, that the subject requires no farther explanation. The rest of the buildings form an antique palace, which has seldom been inhabited by any but prisoners since the reign of Ferdinand and Isabella, who were much attached to this situation. There are some magnificent halls in it, with much gilding in the ceilings, in a semi-barbarous taste. All the kings of Spain are seated in state along the cornice of the great saloon; but it is doubtful whether they are like the princes whose names they bear; if that resemblance, however, be wanting, they have no other merit to claim. The royal apartments are now occupied by a college of young gentlemen cadets, educated at the king's expence in all the sciences requisite for forming an engineer. The grand-master of the ordnance resides at Segovia, which is the head establishment of the Spanish artillery.

The mint is below the alcazar, a large building, the most ancient place of coinage in the kingdom. The machines for melting, stamping, and milling the coin, are worked by water: but there is reason to believe that Seville has at present more business, as being nearer the source of riches, the port of Cadiz, where the ingots of America are landed.

The unevenness of the crown of the hill gives a wild look to this city. Most of the streets are crooked and dirty, the houses wooden and very wretched; nor do the inhabitants appear much the richer for their cloth manufactory. Indeed, it is not in a very flourishing condition, but what cloth they make is very fine.

The country about Segovia has the reputation of being the best for rearing the kind of sheep that produces the beautiful Spanish wool; but as those flocks wander over many other parts of the kingdom, Segovia seems to have no exclusive title to this reputation. Segovia (says Mr Townsend, whose valuable travels will be read with much pleasure) was once famous for its cloth made on the

the king's account; but other nations have ſince become rivals in this branch, and the manufacture in this city has been gradually declining. When the king gave it up to a private company, he left about 3000l. in trade; but now he is no longer a partner in the buſineſs. In the year 1612 were made here 25,500 pieces of cloth, which conſumed 44,625 quintals of wool, employed 34,189 perſons; but at preſent they make only about 4000 pieces. The principal imperfections of this cloth are, that the thread is not even, and that much greaſe remains in it when it is delivered to the dyer; in conſequence of which the colour is apt to fail. Yet, independently of imperfections, ſo many are the diſadvantages under which the manufacture labours, that foreigners can afford to pay 3l. for the aroba of fine wool, for which the Spaniard gives no more than 20s. and after all his charges can command the market even in the ports of Spain.

Townſend's Journey through Spain.

SEGOVIA, *New*, a town of North America, in New Spain, and in the audience of Guatimala; ſeated on the river Yare, on the confines of the province of Honduras. W. Long. 84. 30. N. Lat. 13. 25.

SEGOVIA, a town of America, in Terra Firma, and in the province of Venezuela, ſeated on a river, near a very high mountain, where there are mines of gold. W. Long. 65. 30. N. Lat. 8. 20.

SEGOVIA, a town of Aſia, in the iſland of Manila, and one of the largeſt of the Philippines, ſeated at the north end of the iſland, 240 miles north of Manila, and ſubject to Spain. E. Long. 120. 59. N. Lat. 18. 36.

SEGREANT, is the herald's word for a griffin when drawn in a leaping poſture, and diſplaying his wings as if ready to fly.

SEGUE, in the Italian muſic, is often found before *aria*, *alleluja*, *amen*, &c. to ſhow that thoſe portions or parts are to be ſung immediately after the laſt note of that part over which it is writ; but if theſe words *ſi placet*, or *ad libitum*, are joined therewith, it ſignifies, that theſe portions may be ſung or not at pleaſure.

SEGUIERIA, a genus of plants belonging to the claſs polyandria. See BOTANY *Index*.

SEJANT, a term uſed in heraldry, when a lion, or other beaſt, is drawn in an eſcutcheon ſitting like a cat with his fore-feet ſtraight.

SEJANUS, ÆLIUS, a native of Vulſinum in Tuſcany, who diſtinguiſhed himſelf in the court of Tiberius. His father's name was Seius Strabo; a Roman knight, commander of the pretorian guards. His mother was deſcended from the Junian family. Sejanus firſt gained the favour of Caius Cæſar, the grandſon of Auguſtus, but afterwards he attached himſelf to the intereſt and the views of Tiberius, who then ſat on the imperial throne. The emperor, who was naturally of a ſuſpicious temper, was free and open with Sejanus, and while he diſtruſted others, he communicated his greateſt ſecrets to this fawning favourite. Sejanus improved this confidence; and when he had found that he poſſeſſed the eſteem of Tiberius, he next endeavoured to become the favourite of the ſoldiers, and the darling of the ſenate. As commander of the pretorian guards he was the ſecond man in Rome, and in that important office he made uſe of inſinuations and every mean artifice to make himſelf beloved and revered. His affability and condenſcenſion gained him the hearts of the common ſoldiers, and, by appointing his own favourites and adherents to places of truſt and honour, all the officers and centurions of the army became devoted to his intereſt. The views of Sejanus in this were well known; yet, to advance with more ſucceſs, he attempted to gain the affection of the ſenators. In this he met with no oppoſition. A man who has the diſpoſal of places of honour and dignity, and who has the command of the public money, cannot but be the favourite of thoſe who are in need of his aſſiſtance. It is even ſaid, that Sejanus gained to his views all the wives of the ſenators, by a private and moſt ſacred promiſe of marriage to each of them, whenever he had made himſelf independent and ſovereign of Rome. Yet, however ſucceſsful with the beſt and nobleſt families in the empire, Sejanus had to combat numbers in the houſe of the emperor; but theſe ſeeming obſtacles were ſoon removed. All the children and grandchildren of Tiberius were ſacrificed to the ambition of the favourite under various pretences; and Druſus the ſon of the emperor, by ſtriking Sejanus, made his deſtruction ſure and inevitable. Livia, the wife of Druſus, was gained by Sejanus; and, though the mother of many children, ſhe was prevailed upon to aſſiſt her adulterer in the murder of her huſband, and ſhe conſented to marry him when Druſus was dead. No ſooner was Druſus poiſoned, than Sejanus openly declared his wiſh to marry Livia. This was ſtrongly oppoſed by Tiberius; and the emperor, by recommending Germanicus to the ſenators for his ſucceſſor, rendered Sejanus bold and determined. He was more urgent in his demands; and, when he could not gain the conſent of the emperor, he perſuaded him to retire to ſolitude from the noiſe of Rome and the troubles of the government. Tiberius, naturally fond of eaſe and luxury, yielded to his repreſentations, and retired to Campania, leaving Sejanus at the head of the empire. This was highly gratifying to the favourite, but he was not without a maſter. Prudence and moderation might have made him what he wiſhed to be; but having offended the emperor beyond forgiveneſs, he reſolved to retrieve his loſs, and by one vigorous effort to decide the fate of the empire. He called together his friends and followers; he paid court to ſuch as ſeemed diſſaffected; he held forth rewards and promiſes; and, having increaſed the number of his partiſans, formed a bold conſpiracy, reſolved by any means to ſeize the ſovereign power.

Lempriere's Dictionary.

A powerful league was formed with aſtoniſhing rapidity, and great numbers of all deſcriptions, ſenators as well as military men, entered into the plot. Among theſe, Satrius Secundus was the confidential friend and prime agent of the miniſter. Whatever was this man's motive, whether fear, or views of intereſt, or ingratitude (for no principle of honour can be imputed to him), he reſolved to betray the ſecret to Tiberius. For this purpoſe he addreſſed himſelf to Antonia, the daughter of Anthony the triumvir, the widow of Druſus, and the mother of Germanicus. When this illuſtrious woman, who was honoured by the court and revered by the people, heard the particulars, ſhe ſent diſpatches to the emperor by one of her ſlaves. Tiberius was aſtoniſhed, but not diſmayed. The danger preſſed; his habitual ſlowneſs was out of ſeaſon; the time called for vigour and deciſive meaſures. He ſent Macro to Rome, with a ſpecial commiſſion to take upon him the command of the prætorian guards. He added full inſtructions for his

Murphy's Tacit. Book v.

Sejanus. his conduct in all emergencies. Early in the morning on the 15th, before the kalends of November, a report was ſpread, that letters had arrived at Rome, in which the emperor ſignified his intentions to aſſociate Sejanus with himſelf in the tribunitian power. The ſenate was ſummoned to meet in the temple of Apollo, near the imperial palace. Sejanus attended without delay. A party of the prætorians followed him. Macro met him in the veſtibule of the temple. He approached the miniſter with all demonſtrations of profound reſpect, and taking him aſide, "Be not ſurpriſed (he ſaid) that you have no letter from the prince: it is his pleaſure to declare you his colleague in the tribunitian power; but he thinks that a matter of ſo much importance ſhould be communicated to the fathers by the voice of the conſuls. I am going to deliver the emperor's orders." Sejanus, elated with joy, and fluſhed with his new dignity, entered the ſenate-houſe; Macro followed him. As ſoon as the conſuls arrived, he delivered the letter from Tiberius, and immediately went forth to the prætorian guards. He informed them, that by order of the prince, a large donative was to be diſtributed among the ſoldiers. He added, that, by a new commiſſion, he himſelf was appointed their commanding officer; and, if they followed him to the camp, they would there receive the promiſed bounty. The lure was not thrown out in vain: the prætorian guards quitted their ſtation. Laco, who ſtood near at hand, immediately ſurrounded the ſenate-houſe with a body of the city cohorts.

The letter to the conſuls was confuſed, obſcure, and tedious, only glancing at Sejanus, till at laſt the language of invective left no room for doubt. Sejanus kept his ſeat like a man benumbed, ſenſeleſs and ſtupid with aſtoniſhment. His friends, who a little before congratulated him on his new dignity, deſerted him on every ſide. He was commanded by the conſul to riſe and follow him, and being loaded with irons, was conducted to priſon. His downfal filled the city with exultation. The populace, who worſhipped him in the hour of proſperity, rejoiced to ſee the ſad cataſtrophe to which he was now reduced. They followed in crowds, rending the air with ſhouts, and pouring forth a torrent of abuſe and ſcurrilous language. The priſoner endeavoured to hide his face; but the mob delighted to ſee remorſe and ſhame and guilt and horror in every feature of his diſtracted countenance. They reviled him for his acts of cruelty; they laughed at his wild ambition; they tore down his images, and daſhed his ſtatues to pieces. He was doomed by Tiberius to ſuffer death on that very day; but, as he had a powerful faction in the ſenate, it was not thought adviſeable, for the mere formality of a regular condemnation, to hazard a debate. Private orders were given to Macro to diſpatch him without delay; but the conſul, ſeeing the diſpoſitions of the people, and the calm neutrality of the prætorian guards, judged it beſt to re-aſſemble the fathers. They met in the temple of Concord. With one voice Sejanus was condemned to die, and the ſentence was executed without delay. He was ſtrangled in the priſon. His body was dragged to the Gemoniæ, and, after every ſpecies of inſult from the populace, at the end of three days was thrown into the Tiber. Such was the tragic end of that ambitious favourite. He fell a terrible example to all, who, in any age or country, may hereafter endeavour by their vices to riſe above their fellow-citizens.

Seignior || Seiſin.

SEIGNIOR, is, in its general ſignification, the ſame with *lord*, but is particularly uſed for the lord of the fee as of a manor, as *ſeigneur* among the feudiſts is he who grants a fee or benefit out of the land to another; and the reaſon is, becauſe having granted away the uſe and profit of the land, the property or dominion he ſtill retains in himſelf.

SEIGNIORAGE, is a royalty or prerogative of the king, whereby he claims an allowance of gold and ſilver brought in the maſs to be exchanged for coin. As ſeigniorage, put of every pound weight of gold, the king had for his coin 5s. of which he paid to the maſter of the mint ſometimes 1s. and ſometimes 1s. 6d. Upon every pound weight of ſilver, the ſeigniorage anſwered to the king in the time of Edward III. was 18 pennyweights, which then amounted to about 1s. out of which he ſometimes paid 8d. at others 9d. to the maſter. In the reign of King Henry V. the king's ſeigniorage of every pound of ſilver was 15d. &c.

SEIGNIORY, is borrowed from the French *ſeigneurie*, i. e. *dominatus*, *imperium*, *principatus;* and ſignifies with us a manor or lordſhip, *ſeigniory de ſokemans*. *Seigniory in groſs*, ſeems to be the title of him who is not lord by means of any manor, but immediately in his own perſon; as *tenure in capite*, whereby one holds of the king, as of his crown, is *ſeigniory in groſs*.

SEIKS. See HINDOSTAN.

SEISIN, in *Law*, ſignifies poſſeſſion. In this ſenſe we ſay, *premier ſeiſin*, for the firſt poſſeſſion, &c.

Seiſin is divided into that *in deed* or *in fact*, and that *in law*. A ſeiſin in *deed* is where a poſſeſſion is actually taken: but a ſeiſin in *law* is, where lands deſcend, and the party has not entered thereon; or, in other words, it is where a perſon has a right to lands, &c. and is by wrong diſſeiſed of them. A ſeiſin in law is held to be ſufficient to avow on; though to the bringing of an aſſize, actual ſeiſin is required; and where ſeiſin is alleged, the perſon pleading it muſt ſhow of what eſtate he is ſeiſed, &c.

Seiſin of a ſuperior ſervice is deemed to be a ſeiſin of all ſuperior and caſual ſervices that are incident thereto; and ſeiſin of a leſſee for years, is ſufficient for him in reverſion.

Livery of SEISIN, in *Law*, an eſſential ceremony in the conveyance of landed property; being no other than the pure feodal inveſtiture, or delivery of corporal poſſeſſion of the land or tenement. This was held abſolutely neceſſary to complete the donation; *Nam feudam ſine inveſtitura nullo modo conſtitui potuit:* and an eſtate was then only perfect when, as Fleta expreſſes it in our law, *fit juris et ſeiſinæ conjunctio*. See FEOFMENT.

Inveſtitures, in their original riſe, were probably intended to demonſtrate in conquered countries the actual poſſeſſion of the lord; and that he did not grant a bare litigious right, which the ſoldier was ill qualified to proſecute, but a peaceable and firm poſſeſſion. And, at a time when writing was ſeldom practiſed, a mere oral gift, at a diſtance from the ſpot that was given, was not likely to be either long or accurately retained in the memory of byſtanders, who were very little intereſted in the grant. Afterwards they were retained as a public and notorious act, that the country might take notice of and

teſtify

Seisin. testify the transfer of the estate; and that such as claimed title by other means might know against whom to bring their actions.

In all well governed nations, some notoriety of this kind has been ever held requisite, in order to acquire and ascertain the property of lands. In the Roman law, *plenum dominium* was not said to subsist unless where a man had both the *right* and the *corporal possession*; which possession could not be acquired without both an actual intention to possess, and an actual seisin or entry into the premisses, or part of them in the name of the whole. And even in ecclesiastical promotions, where the freehold passes to the person promoted, corporal possession is required at this day to vest the property completely in the new proprietor; who, according to the distinction of the canonists, acquires the *jus ad rem*, or inchoate and imperfect right, by nomination and institution; but not the *jus in re*, or complete and full right, unless by corporal possession. Therefore in dignities possession is given by instalment; in rectories and vicarages by induction; without which no temporal rights accrue to the minister, though every ecclesiastical power is vested in him by institution. So also even in descents of lands, by our law, which are cast on the heir by act of the law itself, the heir has not *plenum dominium*, or full and complete ownership, till he has made an actual corporal entry into the lands: for if he dies before *entry* made, *his* heir shall not be entitled to take the possession, but the heir of the person who was last actually seised. It is not therefore only a mere right to enter, but the actual entry, that makes a man complete owner; so as to transmit the inheritance to his own heirs: *non jus, sed seisina, facit stipitem.*

Yet the corporal tradition of lands being sometimes inconvenient, a symbolical delivery of possession was in many cases anciently allowed; by transferring something near at hand, in the presence of credible witnesses, which by agreement should serve to represent the very thing designed to be conveyed; and an occupancy of this sign or symbol was permitted as equivalent to occupancy of the land itself. Among the Jews we find the evidence of a purchase thus defined in the book of Ruth: "Now this was the manner in former time in Israel, concerning redeeming and concerning changing, for to confirm all things: a man plucked off his shoe, and gave it to his neighbour; and this was a testimony in Israel." Among the ancient Goths and Swedes, contracts for the sale of lands were made in the presence of witnesses, who extended the cloak of the buyer, while the seller cast a clod of the land into it, in order to give possession; and a staff or wand was also delivered from the vender to the vendee, which passed through the hands of the witnesses. With our Saxon ancestors the delivery of a turf was a necessary solemnity to establish the conveyance of lands. And, to this day, the conveyance of our copyhold estates is usually made from the seller to the lord or his steward by delivery of a rod or verge, and then from the lord to the purchaser by re-delivery of the same in the presence of a jury of tenants.

Conveyances in writing were the last and most refined improvement. The mere delivery of possession, either actual or symbolical, depending on the ocular testimony and remembrance of the witnesses, was liable to be forgotten or misrepresented, and became frequently incapable of proof. Besides, the new occasions and necessities introduced by the advancement of commerce, required means to be devised of charging and incumbering estates, and of making them liable to a multitude of conditions and minute designations, for the purposes of raising money, without an absolute sale of the land; and sometimes the like proceedings were found useful in order to make a decent and competent provision for the numerous branches of a family, and for other domestic views. None of which could be effected by a mere, simple, corporal transfer of the soil from one man to another, which was principally calculated for conveying an absolute unlimited dominion. Written deeds were therefore introduced, in order to specify and perpetuate the peculiar purposes of the party who conveyed: yet still, for a very long series of years, they were never made use of, but in company with the more ancient and notorious method of transfer by delivery of corporal possession. Seisin.

Livery of seisin, by the common law, is necessary to be made upon every grant of an estate of freehold in hereditaments corporeal, whether of inheritance or for life only. In hereditaments incorporeal it is impossible to be made; for they are not the object of the senses: and in leases for years, or other chattel interests, it is not necessary. In leases for years indeed an actual *entry* is necessary, to vest the estate in the lessee: for a bare lease gives him only a right to enter, which is called his interest in the term, or *interesse termini*: and when he enters in pursuance of that right, he is then, and not before, in possession of his term, and complete tenant for years. This entry by the tenant himself serves the purpose of notoriety, as well as livery of seisin from the granter could have done; which, it would have been improper to have given in this case, because that solemnity is appropriated to the conveyance of a freehold. And this is one reason why freeholds cannot be made to commence *in futuro*, because they cannot (at the common law) be made but by livery of seisin; which livery, being an actual manual tradition of the land, must take effect *in præsenti*, or not at all.

Livery of seisin is either in *deed* or in *law*.

Livery in *deed* is thus performed. The feoffor, lessor, or his attorney, together with the feoffee, lessee, or his attorney, (for this may as effectually be done by deputy or attorney as by the principals themselves in person), come to the land or to the house; and there, in the presence of witnesses, declare the contents of the feoffment or lease on which livery is to be made. And then the feoffor, if it be of land, doth deliver to the feoffee, all other persons being out of the ground, a clod or turf, or a twig or bough there growing, with words to this effect: "I deliver these to you in the name of seisin of all the lands and tenements contained in this deed." But, if it be of a house, the feoffor must take the ring or latch of the door, the house being quite empty, and deliver it to the feoffee in the same form; and then the feoffee must enter alone, and shut the door, and then open it, and let in the others. If the conveyance or feoffment be of divers lands, lying scattered in one and the same county, then in the feoffor's possession, livery of seisin of any parcel, in the name of the rest, sufficeth for all; but if they be in several counties, there must be as many liveries as there are counties. For, if the title to these lands comes to be disputed, there must

must be as many trials as there are counties, and the jury of one county are no judges of the notoriety of a fact in another. Besides, anciently, this seisin was obliged to be delivered *coram paribus de vicineto*, before the peers or freeholders of the neighbourhood, who attested such delivery in the body or on the back of the deed; according to the rule of the feodal law, *Pares debent interesse investituræ feudi, et non alii*: for which this reason is expressly given; because the peers or vassals of the lord, being bound by their oath of fealty, will take care that no fraud be committed to his prejudice, which strangers might be apt to connive at. And though afterwards the ocular attestation of the *pares* was held unnecessary, and livery might be made before any credible witnesses, yet the trial, in case it was disputed, (like that of all other attestations), was still reserved to the *pares* or jury of the county. Also, if the lands be out on lease, though all lie in the same county, there must be as many liveries as there are tenants: because no livery can be made in this case, but by the consent of the particular tenant; and the consent of one will not bind the rest. And in all these cases it is prudent, and usual, to endorse the livery of seisin on the back of the deed, specifying the manner, place, and time of making it; together with the names of the witnesses. And thus much for livery in deed.

Livery in *law* is where the same is not made *on* the land, but *in sight of it* only; the feoffor saying to the feoffee, "I give you yonder land, enter and take possession." Here, if the feoffee enters during the life of the feoffor, it is a good livery, but not otherwise; unless he dares not enter through fear of his life or bodily harm; and then his continual claim, made yearly in due form of law, as near as possible to the lands, will suffice without an entry. This livery in law cannot, however, be given or received by attorney, but only by the parties themselves.

SEIZE, in the sea-language, is to make fast or bind, particularly to fasten two ropes together with rope-yarn. The seizing of a boat is a rope tied to a ring or little chain in the fore-ship of the boat, by which means it is fastened to the side of the ship.

SEIZURE, in commerce, an arrest of some merchandise, moveable, or other matter, either in consequence of some law or of some express order of the sovereign. Contraband goods, those fraudulently entered, or landed without entering at all, or at wrong places, are subject to seizure. In seizures among us, one half goes to the informer, and the other half to the king.

SELAGO, a genus of plants belonging to the didynamia class; and in the natural method ranking under the 48th order, *Aggregatæ*. See BOTANY *Index*.

SELDEN, JOHN, called by Grotius *the glory of England*, was born at Salvington in Sussex in 1584. He was educated at the free school at Chichester; whence he was sent to Hart Hall in the university of Oxford, where he staid four years. In 1612, he entered himself in Clifford's Inn, in order to study the law; and about two years after removed to the Inner Temple, where he soon acquired great reputation by his learning. He had already published several of his works; and this year wrote verses in Latin, Greek, and English, upon Mr William Browne's Britannia's Pastorals. In 1614, he published his Titles of Honour; and in 1616, his Notes on Sir John Fortescue's book *De Laudibus Legum Angliæ*. In 1618, he published his History of Tythes; which gave great offence to the clergy, and was animadverted upon by several writers; and for that book he was called before the high commission court, and obliged to make a public acknowledgment of his sorrow for having published it. In 1621, being sent for by the parliament, though he was not then a member of that house, and giving his opinion very strongly in favour of their privileges in opposition to the court, he was committed to the custody of the sheriff of London, but was set at liberty after five weeks confinement. In 1623, he was chosen burgess for Lancaster; but, amidst all the divisions of the nation, kept himself neuter, prosecuting his studies with such application, that though he was the next year chosen reader of Lyon's Inn, he refused to perform that office. In 1625, he was chosen burgess for Great Bedwin in Wiltshire, to serve in the first parliament of King Charles I. in which he declared himself warmly against the duke of Buckingham; and on his Grace's being impeached by the House of Commons, was appointed one of the managers of the articles against him. In 1627 and 1628, he opposed the court party with great vigour. The parliament being prorogued to January 20. 1629, Mr Selden retired to the earl of Kent's house at Wrest, in Bedfordshire, where he finished his *Marmora Arundeliana*. The parliament being met, he, among others, again distinguished himself by his zeal against the court; when the king dissolving the parliament, ordered several of the members to be brought before the King's Bench bar, and committed to the Tower. Among these was Mr Selden, who insisting on the benefit of the laws, and refusing to make his submission, was removed to the King's Bench prison. Being here in danger of his life on account of the plague then raging in Southwark, he petitioned the lord high treasurer, at the end of Trinity term, to intercede with his Majesty that he might be removed to the Gate-house, Westminster, which was granted: but in Michaelmas term following, the judges objecting to the lord treasurer's warrant, by which he had been removed to the Gate-house, an order was made for conveying him back to the King's Bench, whence he was released in the latter end of the same year; but fifteen years after, the parliament ordered him 5000l. for the losses he had sustained on this occasion. He was afterwards committed with several other gentlemen, for dispersing a libel; but the author, who was abroad, being discovered, they were at length set at liberty. In 1634, a dispute arising between the English and Dutch concerning the herring-fishery on the British coast, he was prevailed upon by Archbishop Laud to draw up his *Mare Clausum*, in answer to Grotius's *Mare Liberum*: which greatly recommended him to the favour of the court. In 1640, he was chosen member for the university of Oxford; when he again opposed the court, though he might, by complying, have raised himself to very considerable posts. In 1643, he was appointed one of the lay-members to sit in the assembly of divines at Westminster, and was the same year appointed keeper of the records in the Tower. Whilst he attended his duty in the assembly, a warm debate arose respecting the distance of Jericho from Jerusalem. The party which contended for the shortest distance, urged, as a proof of their opinion being well founded, that fishes were carried from the one city to the other, and sold in the market. Their adversaries were ready to yield to the force of this conclusive argument, when Selden, who despised both parties, as well as the frivolousness of their dispute, exclaimed, "Perhaps the fishes were salted!" This unexpected remark left the victory doubtful, and renewed the debate; and our author, who was sick of such trifling, soon found employment more suited to his genius; for, in 1645, he was made one of the commissioners of the admiralty. The same year he was unanimously elected master of Trinity college, Cambridge; but declined accepting. He died in 1654; and was interred in the Temple-church, where a monument is erected to his memory. Dr Wilkes observes, that he was a man of uncommon gravity and greatness of soul, averse to flattery, liberal to scholars, charitable to the poor; and though he had great latitude in his principles with regard to ecclesiastical power, yet he had a sincere regard for the church of England. He wrote many learned works besides those already mentioned; the principal of which are, 1. *De Jure Naturali et Gentium juxta Disciplinam Hebræorum.* 1. *De Nuptiis et Divorciis.* 3. *De Anno Civili veterum Hebræorum.* 4. *De Nummis.* 5. *De Diis Syris.* 6. *Uxor Hebraica.* 7. *Jani Anglorum Facies altera,* &c. All his works were printed together in 1726, in 3 vols folio.

SELENITE, in *Mineralogy*, the crystallized sulphate of lime or gypsum. See LIME, in MINERALOGY *Index.* Selenite literally signifies *moon-stone*, and is pressive of the colour and soft lustre of the mineral.

SELENOGRAPHY, a branch of cosmography, which describes the moon and all the parts and appearances thereof, as geography does those of the earth. See MOON, and ASTRONOMY *Index.*

SELEUCIA, in *Ancient Geography*, surnamed *Babylonia*, because situated on its confines, at the confluence of the Euphrates and Tigris. Ptolemy places it in Mesopotamia. It is called also *Seleucia ad Tigrim*, (Polybius, Strabo, Isidorus Characenus); washed on the south by the Euphrates, on the east by the Tigris, (Theophylactus); generally agreed to have been built or enlarged by Seleucus Nicanor, master of the east after Alexander; by means of which Babylon came to be deserted. It is said to have been originally called *Coche*, (Ammian, Eutropius); though others, as Arrian, distinguish it, as a village, from *Selucia*: and, according to Zosimus, the ancient name of Selucia was *Zochasia.* Now called *Bagdad.* E. Long. 44. 21. N. Lat. 33. 10. There were many other cities of the same name, all built by Seleucus Nicanor.

SELEUCIDÆ, in *Chronology.* Era of the Seleucidæ, or the Syro-Macedonian era, is a computation of time, commencing from the establishment of the Seleucidæ, a race of Greek kings, who reigned as successors of Alexander the Great in Syria, as the Ptolemies did in Egypt. This era we find expressed in the books of the Maccabees, and on a great number of Greek medals struck by the cities of Syria, &c. The Rabbins call it the *era of contracts*, and the Arabs *therik dilkarnain*, that is, the "era of the two horns." According to the best accounts, the first year of this era falls in the year 311 B. C. being 12 years after Alexander's death.

SELEUCUS, NICANOR, one of the chief generals under Alexander the Great, and, after his death, founder of the race of princes called *Seleucidæ.* He is equally celebrated as a renowned warrior, and as the father of his people; yet his virtues could not protect him from the fatal ambition of Ceraunus, one of his courtiers, by whom he was assassinated 280 B. C.

SELF-HEAL, the PRUNELLA VULGARIS, Lin. This herb was recommended by the older physicians as a mild restringent and vulnerary; but its virtues appear to be very feeble, and therefore it is now rarely used.

SELF Command, is that steady equanimity which enables a man in every situation to exert his reasoning faculty with coolness, and to do what the present circumstances require. It depends much upon the natural temperament of the body, and much upon the moral cultivation of the mind. He who enjoys good health, and has braced his frame by exercise, has always a greater command of himself than a man of equal mental powers, who has suffered his constitution to become relaxed by indolence; and he who has from his early youth been accustomed to make his passions submit to his reason, must, in any sudden emergency, be more capable of acting properly than he who has tamely yielded to his passion. Hence it is that recluse and literary men, when forced into the bustle of public life, are incapable of acting where promptness is requisite; and that men who have once or twice yielded to a sense of impending danger seldom acquire afterwards that command of themselves which may be necessary to extricate them from subsequent dangers. In one of the earliest battles fought by the late king of Prussia, the sovereign was among the first men who quitted the field: had he behaved in the same manner a second and a third time, he would never have become that hero whose actions astonished Europe. A celebrated engineer among ourselves, who was well known to the writer of this short article, had little science, and was a stranger to the principles of his own art; but being possessed of a firm and vigorous frame, and having been accustomed to struggle with dangers and difficulties, he had such a constant command of himself, as enabled him to employ with great coolness every necessary resource in the day of battle.

But it is not only in battle, and in the face of immediate danger, that self-command is necessary to enable a man to act with propriety. There is no situation in life where difficulties, greater or less, are not to be encountered; and he who would pass through life with comfort to himself, and with utility to the public, must endeavour to keep his passions in constant subjection to his reason. No man can enjoy without inquietude what he cannot lose without pain; and no man who is overwhelmed with despondency under any sudden misfortune can exert the talents necessary to retrieve his circumstances. We ought, therefore, by every means to endeavour to obtain a constant command of ourselves; and nowhere shall we find better lessons for this purpose than in ancient Lacedemon. There certain occupations were appointed for each sex, for every hour, and for every season of life. In a life always active, the passions have no opportunity to deceive, seduce, or corrupt; and the nervous system acquires a firmness which makes it a fit instrument to a vigorous mind.

SELF-Defence implies not only the preservation of one's life, but also the protection of his property, because caufe without property life cannot be preferved in a civilized nation. The extent of property effential to life is indeed fmall, and this confideration may enable us to decide a queftion which fome moralifts have made intricate. By what means, it has been afked, may a man protect his property? May he kill the perfon who attacks it, if he cannot otherwife repel the attack?

That a man, in the ftate of nature, may kill the perfon who makes an attack on his life, if he cannot otherwife repel the attack, is a truth which has never been controverted; and he may do the fame in civil fociety, if his danger be fo imminent that it cannot be averted by the interpofition of the protection provided for individuals by the ftate. In all poffible fituations, except the three following, whatever is abfolutely neceffary to the prefervation of life may be lawfully performed, for the law of felf-prefervation is the firft and moft facred of thofe laws which are impreffed on every mind by the author of nature.

The three excepted fituations are thofe of a foldier in the day of battle, of a criminal about to fuffer by the laws of his country, and of a man called upon to renounce his religion. The foldier hazards his life in the moft honourable of all caufes, and cannot betray his truft, or play the coward, without incurring a high degree of moral turpitude. He knows that the very profeffion in which he is engaged neceffarily fubjects him to danger; and he voluntarily incurred that danger for the good of his country, which, with great propriety, annexes to his profeffion peculiar privileges and much glory. The criminal under fentence of death cannot, without adding to his guilt, refift the execution of that fentence; for the power of inflicting punifhment is effential to fociety, and fociety is the ordinance of God, (fee SOCIETY). The man who is called upon to renounce his religion ought to fubmit to the cruelleft death rather than comply with that requeft, fince religion is his only fecurity for future and permanent happinefs. But in every other fituation, that which is abfolutely neceffary to the prefervation of life is undoubtedly lawful. Hence it is, that a perfon finking in water is never thought to be guilty of any crime, though he drag his neighbour after him by his endeavours to fave himfelf; and hence, too, a man in danger of perifhing by fhipwreck may drive another from a plank which cannot carry them both, for fince one of two lives muft be loft, no law, human or divine, calls upon either of them to prefer his neighbour's life to his own.

But though the rights of felf-defence authorife us to repel every attack made upon our life, and in cafes of extremity to fave ourfelves at the expence of the life of our innocent neighbour, it is not fo evident that, rather than give to an unjuft demand a few fhillings or pounds, we may lawfully deprive a fellow creature of life, and the public of a citizen. A few pounds loft may be eafily regained; but life when loft can never be recovered. If thefe pounds, indeed, be the whole of a man's property; if they include his clothes, his food, and the houfe where he fhelters his head—there cannot be a doubt but that, rather than part with them, he may lawfully kill the aggreffor, for no man can exift without fhelter, food, and raiment. But it is feldom that an attempt is made, or is indeed practicable, to rob a man at once of all that he poffeffes. The queftion then of any importance is, May a man put a robber to death rather than part with a fmall part of his property? Mr Paley doubts whether he could innocently do fo in a ftate of nature, "becaufe it cannot be contended to be for the augmentation of human happinefs, that one man fhould lofe his life or limb, rather than another a pennyworth of his property." He allows, that in civil fociety the life of the aggreffor may be always taken away by the perfon aggrieved, or meant to be aggrieved, when the crime attempted is fuch as would fubject its perpetrator to death by the laws of his country.

It is not often that we feel ourfelves difpofed to differ in opinion from this moft valuable and intelligent writer; but on the prefent occafion we cannot help thinking that he does not reafon with his ufual precifion. To us he even feems to lofe fight of his own principles. No legiflature can have a right to take away life in civil fociety, but in fuch cafes as individuals have the fame right in a ftate of nature. If therefore a man in the ftate of nature, have not a right to protect his property by killing the aggreffor, when it cannot be otherwife protected, it appears to us felf-evident that no legiflature can have a right to inflict the punifhment of death upon fuch offences; but if the laws inflicting death upon the crime of robbery be morally evil, it is certain that an individual cannot be innocent when he prevents robbery by the death of the robber, merely becaufe he knows that the laws of his country have decreed that punifhment againft thofe convicted of that crime. But we think that the protection of property by the death of the aggreffor may be completely vindicated upon more general principles. It is neceffary, in every ftate, that property be protected, or mankind could not fubfift; but in a ftate of nature every man muft be the defender of his own property, which in that ftate muft neceffarily be fmall: and if he be not allowed to defend it by every mean in his power, he will not long be able to protect it at all. By giving him fuch liberty, a few individuals may, indeed, occafionally lofe their lives and limbs for the prefervation of a very fmall portion of private property; but we believe that the fum of human happinefs will be more augmented by cutting off fuch worthlefs wretches than by expofing property to perpetual depredation; and therefore, if general utility be the criterion of moral good, we muft be of opinion that a man may in every cafe lawfully kill a robber rather than comply with his unjuft demand.

But if a man may without guilt preferve his property by the death of the aggreffor, when it cannot be preferved by any other means, much more may a woman have recourfe to the laft extremity to protect her chaftity from forcible violation. This, indeed, is admitted by Mr Paley himfelf, and will be controverted by no man who reflects on the importance of the female character, and the probable confequences of the fmalleft deviation from the eftablifhed laws of female honour. See SEDUCTION.

SELF-Knowledge, the knowledge of one's own character, abilities, opinions, virtues, and vices. This has always been confidered as a difficult though important acquifition. It is difficult, becaufe it is difagreeable to inveftigate our errors, our faults, and vices; becaufe we are apt to be partial to ourfelves, even when we have done wrong; and becaufe time and habitual attention are

Self. are requisite to enable us to discover our real character. But these difficulties are more than counterbalanced by the advantages of self-knowledge.

By knowing the extent of our abilities, we shall never rashly engage in enterprises where our ineffectual exertions may be productive of harm: by investigating our opinions, we may discover those which have no foundation, and those also which lead us insensibly into vice. By examining our virtues and vices, we shall learn what principles ought to be strengthened, and what habits ought to be removed.

Man is a rational and intelligent being, capable of great improvement, and liable to great vices. If he act without examining his principles, he may be hurried by blind passion into crimes. If he aspire at noble and valuable acquisitions, he must act upon a plan, with deliberation and fore thought; for he is not like a vegetable, which attains perfection by the influence of external causes: he has powers within himself which must be exerted, and exerted with judgement, in order to attain the perfection of his nature. To enable him to employ these powers aright, he must know, first, what is his duty; and, secondly, he must often review his principles and conduct, that he may discover whether he is performing his duty, or in what circumstances he has failed. When he finds that he has fallen into error and vice, he will naturally inquire what causes have produced this effect, that he may avoid the same for the time to come. This is the method by which every reformation in religion and science has been produced, and the method by which the arts have been improved. Before Lord Bacon introduced the new way of philosophizing, he must first have considered wherein true philosophy consisted; secondly, he must have inquired in what respects the ancient method of philosophizing was false or useless: and after determining these two points, he was qualified to describe the way by which the study of philosophy could be successfully pursued without deviating into hypothesis and error. Luther found out the errors of the church of Rome by comparing their doctrines with the Scriptures. But had this comparison never been made, the reformation could never have taken place. Without self-knowledge, or without that knowledge of our character which is derived from a comparison of our principles and conduct with a perfect standard of morality, we can never form plans and resolutions, or make any exertion to abandon the vicious habits which we have contracted, and strengthen those virtuous principles in which we are deficient.

As much may be learned from the errors of those who have been in similar situations with ourselves; so many useful cautions may be obtained from our own errors; and he that will remember these, will seldom be twice guilty of the same vice.

It was evidently the intention of Providence that man should be guided chiefly by experience. It is by the observation which we make on what we see passing around us, or from what we suffer in our own persons, that we form maxims for the conduct of life. The more minutely [illegible] our principles, and the more maxims [illegible], we shall be the better fitted to attain moral [illegible].

With respect [illegible] to [illegible] the errors which we [illegible], either [illegible]

defects or by negligence, is also of great importance; Self. for the greatest genius and most profound scholar are liable to these errors, and often commit them as well as the weak and illiterate. But by observing them, and tracing them to their causes, they at length acquire an habitual accuracy. It is true, that men of feeble minds can never by knowing their own defects exalt themselves to the rank of genius; but such knowledge will enable them to improve their understandings, and so to appreciate their own powers, as seldom to attempt what is beyond their strength. They may thus become useful members of society; and though they will not probably be admired for their abilities, they will yet escape the ridicule which is poured upon vanity.

It is difficult to lay down precise rules for the acquisition of this self-knowledge, because almost every man is blinded by a fallacy peculiar to himself. But when one has got rid of that partiality which arises from self-love, he may easily form a just estimate of his moral improvements, by comparing the general course of his conduct with the standard of his duty; and if he has any doubt of the extent of his intellectual attainments, he will most readily discover the truth by comparing them with the attainments of others who have been most successful in the same pursuits. Should vanity arise in his mind from such a comparison, let him then compare the extent of his knowledge with what is yet to be known, and he will then be in little danger of thinking of himself more highly than he ought to think. See Prejudice and *Self Partiality*.

Self-Love, is that instinctive principle which impels every animal, rational and irrational, to preserve its life and promote its own happiness. It is very generally confounded with selfishness; but we think that the one propensity is distinct from the other. Every man loves himself; but every man is not selfish. The selfish man grasps at all *immediate* advantages, regardless of the consequences which his conduct may have upon his neighbour. Self-love only prompts him who is actuated by it to procure to himself the greatest possible sum of happiness during the whole of his existence. In this pursuit the rational self-lover will often forego a present enjoyment to obtain a greater and more permanent one in reversion; and he will as often submit to a present pain to avoid a greater hereafter. Self-love, as distinguished from selfishness, always comprehends the whole of a man's existence, and in that extended sense of the phrase, we hesitate not to say that every man is a self-lover; for, with eternity in his view, it is surely not possible for the most disinterested of the human race not to prefer himself to all other men, if their future and everlasting interests could come into competition. This indeed they never can do; for though the introduction of evil into the world, and the different ranks which it makes necessary in society, put it in the power of a man to raise himself, in the present state, by the depression of his neighbour, or by the practice of injustice, yet in the pursuit of a prize which is to be gained only by [illegible] righteousness, and piety, there can be no [illegible] competition. The success of [illegible] of the [illegible], self-love is [illegible] useful [illegible] It has [illegible] question in morals, whether it [illegible] action, however, [illegible]

Self.

Those who maintain the affirmative side of this question say, that the prospect of immediate pleasure, or the dread of immediate pain, is the only apparent motive to action in the minds of infants, and indeed of all who look not before them, and infer the future from the past. They own, that when a boy has had some experience, and is capable of making comparisons, he will often decline an immediate enjoyment which he has formerly found productive of future evil more than equivalent to all its good; but in doing so they think, and they think justly, that he is still actuated by the principle of self-love, pursuing the greatest good of which he knows himself to be capable. After experiencing that truth, equity, and benevolence in all his dealings is the readiest, and indeed the only certain method of securing to himself the kindness and good offices of his fellow creatures, and much more when he has learned that they will recommend him to the Supreme Being, upon whom depends his existence and all his enjoyments, they admit that he will practice truth, equity, and benevolence; but still, from the same principle, pursuing his own ultimate happiness as the object which he has always in view. The prospect of this great object will make him feel an exquisite pleasure in the performance of the actions which he conceives as necessary to its attainment, till at last, without attending in each instance to their consequences, he will, by the great associating principle which has been explained elsewhere (see METAPHYSICS, Part I. chap. i.) feel a refined enjoyment in the actions themselves, and perform them, as occasions offer, without deliberation or reflection. Such, they think, is the origin of benevolence itself, and indeed of every virtue.

Those who take the other side of the question, can hardly deny that self-love thus modified may prompt to virtuous and apparently disinterested conduct; but they think it degrading the dignity of a man to suppose him actuated solely by motives which can be traced back to a desire of his own happiness. They observe, that the Author of our nature has not left the preservation of the individual, or the continuance of the species, to the deductions of our reason, computing the sum of happiness which the actions necessary to these ends produce to ourselves: on the contrary, He has taken care of both, by the surer impulse of instinct planted in us for these very purposes. And is it conceivable, say they, that He would leave the care of our fellow-creatures a matter of indifference, till each man should be able to discover or be taught that by loving his neighbour, and doing him all the good in his power, he would be most effectually promoting his own happiness? It is dishonouring virtue, they continue, to make it proceed in any instance from a prospect of happiness, or a dread of misery; and they appeal from theory to fact, as exhibited in the conduct of savage tribes, who deliberate little on the consequences of their actions.

Their antagonists reply, that the conduct of savage tribes is to be considered as that of children in civilized nations, regulated entirely by the examples which they have before them; that their actions cannot be the offspring of innate instincts, otherwise savage virtues would, under similar circumstances, everywhere be the same, which is contrary to fact; that virtue proceeds from an interested motive on either supposition; and that the motive which the instinctive scheme holds up is the most selfish of the two. The other theory supposes, that the governing motive is the hope of *future* happiness and the dread of *future* misery; the instinctive scheme supplies a *present* motive in the self-complacency arising in the heart from a consciousness of right conduct. The former is a rational motive, the latter has nothing more to do with reason than the enjoyment arising from eating or drinking, or from the intercourse between the sexes. But we mean not to pursue the subject farther, as we have said enough on it in the articles BENEVOLENCE, INSTINCT, PASSION, and PHILANTHROPY. We shall therefore conclude with observing, that there is certainly a virtuous as well as a vicious self-love, and that "true self-love and social are the same."

SELF-Murder. See SUICIDE.

SELF-Partiality, is a phrase employed by some philosophers * to express that weakness of human nature through which men overvalue themselves when compared with others. It is distinguished from general partiality, by those who make use of the expression, because it is thought that a man is led to overrate his own accomplishments, either by a particular instinct, or by a process of intellect different from that by which he overrates the accomplishments of his friends or children. The former kind of partiality is wholly selfish; the latter partakes much of benevolence.

* *See Lord Kaimes's Art of Thinking.*

This distinction may perhaps be deemed plausible by those who consider the human mind as little more than a bundle of instincts; but it must appear perfectly ridiculous to such as resolve the greater part of apparent instincts into early and deep-rooted associations of ideas. If the partialities which most men have to their friends, their families, and themselves, be instinctive, they are certainly instincts of different kinds; but an instinctive partiality is a contradiction in terms. Partiality is founded on a comparison between two or more objects; but genuine instincts form no comparisons. See INSTINCT. No man can be said to be partial to the late Dr Johnson, merely for thinking highly of his intellectual powers; nor was the doctor partial to himself, though he thought in this respect with the generality of his countrymen; but if, upon a comparison with Milton, he was deemed the greater poet of the two, such a judgement will be allowed to be partial, whether formed by himself or by any of his admirers. We apprehend, however, that the process of its formation was the same in every mind by which it was held.

The origin of self-partiality is not difficult to be found: and our partialities to our friends may be traced to a similar source. By the constitution of our nature we are impelled to shun pain and to pursue pleasure; but remorse, the severest of all pains, is the never-failing consequence of vicious conduct. Remorse arises from the dread of that punishment which we believe will in a future state be inflicted on vice unrepented of in this; and therefore every vicious person endeavours by all possible means to banish that dread from his own mind. One way of effecting this is to compare his own life with the lives of others; for he fancies that if numbers be as wicked as himself, the benevolent Lord of all things will not involve them in one common ruin. Hence, by magnifying to himself the temptations which led him astray, and diminishing the injuries which his conduct has done in the world, and by adopting a course diametrically the reverse, when estimating the

the morality or immorality of the conduct of his neighbours, he soon comes to believe that he is at least not more wicked than they. Thus is self-partiality formed in the mind, and quickly blinds him who is under its influence so completely, as to hide from him the very faults which he sees and blames in others. Hence the coward thinks himself only cautious, the miser frugal. Partiality is formed in the very same manner to natural or acquired accomplishments, whether mental or corporeal. These always procure respect to him who is possessed of them; and as respect is accompanied with many advantages, every man wishes to obtain it for himself. If he fail in his attempts, he consoles himself with the persuasion that it is at least due to his merits, and that it is only withheld by the envy of the public. He compares the particular branch of science or bodily accomplishment in which he himself most excels, with those which have conferred splendor on his rival; and easily finds that his own excellencies are of the highest order, and entitled to the greatest share of public esteem. Hence the polite scholar despises the mathematician; the reader of Aristotle and Plato all the modern discoveries in physical and moral science; and the mere experimentalist holds in the most sovereign contempt a critical knowledge of the ancient languages. The pupil of the ancients denies the merits of the moderns, whilst the mere modern allows nothing to the ancients; and thus each becomes partial to his own acquisitions, and of course to himself, for having been at the trouble to make them.

Partiality to our friends and families is generated in the very same way. Whenever we acquire such an affection for them as to consider their happiness as adding to our own (see PASSION), we magnify their excellencies, and diminish their defects, for the same reason, and by the same process, that we magnify and diminish our own. All partialities, however, are prejudices, and prejudices of the worst kind. They ought therefore to be guarded against with the utmost care, by the same means which we have elsewhere recommended (see PREJUDICE and METAPHYSICS, N° 98.); and he who is partial to his own virtue or his own knowledge, will do well to compare the former, not with the conduct of his neighbour, but with the express rule of his duty; and to consider the latter as no farther valuable than as it contributes to the sum of human happiness.

SELIM I. emperor of the Turks, was the second son of Bajazet II. He made war upon his father, and though defeated in 1511, he at last dethroned him and took him prisoner, and immediately dispatched him by poison, together with his elder brother Achmet, and his younger Korkud, an amiable and enlightened prince. Having established his throne by these crimes, he marched against Campson-Guary sovereign of Egypt, gained a great victory at Aleppo, and slew their general. But though the sultan perished in that battle, the Mameluks determined to oppose the emperor. Selim entering their country at the head of his army, defeated the Egyptians in two battles, and ordered Toumonbai, the new elected sultan, who had fallen into his hands, to be hung on a gibbet. He then took Cairo and Alexandria, and in a short time reduced all Egypt to subjection. Thus ended the dominion of the Mameluks in Egypt, which had continued for more than 260 years. He confirmed the ancient privileges of the Venetians in Egypt and Syria, by which they carried on their commerce with India, and formed a league with them to destroy the power of the Portuguese in that country. (See INDIA, N° 37.) Selim had before this gained a great victory over the Persians, and stripped them of Tauris and Keman. He was preparing to attack Christendom when he was seized with an ulcerous sore in the back. Thinking that the air of Adrianople would restore his health, he ordered himself to be conducted thither; but he died at Clari in Thrace on his road to that city, in the year 1520, in the very spot where he had poisoned his father. He reigned eight years, and lived 54. He was a prince of great courage, sobriety, and liberality: he was fond of history, and wrote some verses. But these good qualities were obscured by the most abominable crimes that ever disgraced human nature; he made his way to the throne by shedding the blood of his father, and secured it by murdering his brothers and eight nephews, and every bashaw who had been faithful to his duty.

SELINUM, a genus of plants belonging to the pentandria class; and in the natural method ranking under the 45th order, *Umbellatæ*. See BOTANY *Index*.

SELKIRK, ALEXANDER, whose adventures gave rise to a well-known historical romance, was born at Largo, in Fife-shire in Scotland, about the year 1676, and was bred a seaman. He went from England, in 1703, in the capacity of sailing-master of a small vessel called the *Cinque-Ports Galley*, Charles Pickering captain, burthen about 90 tons, with 16 guns and 63 men, and in September the same year sailed from Cork, in company with another ship of 26 guns and 120 men, called the St George, commanded by that famous navigator William Dampier, intended to cruise against the Spaniards in the South sea. On the coast of Brazil, Pickering died, and was succeeded in his command by his lieutenant Thomas Stradling. They proceeded on their voyage round Cape Horn to the island of Juan Fernandes, whence they were driven by the appearance of two French ships of 36 guns each, and left five of Stradling's men there on shore, who were taken off by the French. Hence they sailed to the coast of America, where Dampier and Stradling quarrelled, and separated by agreement, on the 19th of May 1704. In September following, Stradling came again to the island of Juan Fernandes, where Selkirk and his captain had a difference, which, with the circumstance of the ship's being very leaky, and in bad condition, induced him to determine on staying there alone; but when his companions were about to depart, his resolution was shaken, and he desired to be taken on board again. The captain, however, refused to admit him, and he was obliged to remain, having nothing but his clothes, bedding, a gun, and a small quantity of powder and ball; a hatchet, knife, and kettle; his books, and mathematical and nautical instruments. He kept up his spirits tolerably till he saw the vessel put off, when (as he afterwards related) his heart yearned within him, and melted at parting with his comrades and all human society at once.

" ——Yet believe me, Arcas,
Such is the rooted love we bear mankind,

 Al-

Selkirk.

All ruffians as they were, I never heard
A found fo difmal as their parting oars."
Thomfon's Agamemnon.

Thus left fole monarch of the ifland, with plenty of the neceffaries of life, he found himfelf in a fituation hardly fupportable. He had fifh, goat's flefh, turnips and other vegetables; yet he grew dejected, languid, and melancholy, to fuch a degree, as to be fcarce able to refrain from doing violence to himfelf. Eighteen months paffed before he could, by reafoning, reading his bible, and ftudy, he thoroughly reconciled to his condition. At length he grew happy, employing himfelf in decorating his huts, chafing the goats, whom he equalled in fpeed, and fcarcely ever failed of catching. He alfo tamed young kids, laming them to prevent their becoming wild; and he kept a guard of tame cats about him, to defend him when afleep from the rats, who were very troublefome. When his clothes were worn out, he made others of goats fkins, but could not fucceed in making fhoes, with the ufe of which, however, habit, in time, enabled him to difpenfe. His only liquor was water. He computed that he had caught 1000 goats during his abode in the ifland; of which he had let go 500, after marking them by flitting their ears. Commodore Anfon's people, who were there about 30 years after, found the firft goat which they fhot upon landing, was thus marked, and as it appeared to be very old, concluded that it had been under the power of Selkirk. But it appears by Captain Carteret's account of his voyage in the Swallow floop, that other perfons practifed this mode of marking, as he found a goat with his ears thus flit on the neighbouring ifland of Mas-a-fuera, where Selkirk never was. He made companions of his tame goats and cats, often dancing and finging with them. Though he conftantly performed his devotions at ftated hours, and read aloud; yet, when he was taken off the ifland, his language, from difufe of converfation, had become fcarcely intelligible. In this folitude he continued four years and four months; during which time only two incidents happened which he thought worth relating, the occurrences of every day being in his circumftances nearly fimilar. The one was, that, purfuing a goat eagerly, he caught it juft on the edge of a precipice, which was covered with bufhes, fo that he did not perceive it, and he fell over to the bottom, where he lay (according to Captain Roger's account) 24 hours fenfelefs; but, as he related to Sir R. Steele, he computed, by the alteration of the moon, that he had lain three days. When he came to himfelf, he found the goat lying under him dead. It was with great difficulty that he could crawl to his habitation, whence he was unable to ftir for ten days, and did not recover of his bruifes for a long time. The other event was the arrival of a fhip, which he at firft fuppofed to be French: and fuch is the natural love of fociety in the human mind, that he was eager to abandon his folitary felicity, and furrender himfelf to them, although enemies; but upon their landing, approaching them, he found them to be Spaniards, of whom he had too great a dread to truft himfelf in their hands. They were by this time fo near that it required all his agility to efcape, which he effected by climbing into a thick tree, being fhot at feveral times as he ran off. Fortunately the Spaniards did not difcover him, though they ftayed fome time under the tree where he was hid, and killed fome goats juft by. In this folitude Selkirk remained until the 2d of February 1709, when he faw two fhips come into the bay, and knew them to be Englifh. He immediately lighted a fire as a fignal; and on their coming on fhore, found they were the Duke Captain Rogers, and the Duchefs Captain Courtney, two privateers from Briftol. He gave them the beft entertainment he could afford; and, as they had been a long time at fea without frefh provifions, the goats which he caught were highly acceptable. His habitation confifting of two huts, one to fleep in, the other to drefs his food in, was fo obfcurely fituated, and fo difficult of accefs, that only one of the fhip's officers would accompany him to it. Dampier, who was pilot on board the Duke, and knew Selkirk very well, told Captain Rogers, that, when on board the Cinque-Ports, he was the beft feaman in the veffel; upon which Captain Rogers appointed him mafter's mate of the Duke. After a fortnight's ftay at Juan Fernandes, the fhips proceeded on their cruize againft the Spaniards; plundered a town on the coaft of Peru; took a Manilla fhip off California; and returned by way of the Eaft Indies to England, where they arrived the 1ft of October 1711; Selkirk having been abfent eight years, more than half of which time he had fpent alone in the ifland. The public curiofity being excited refpecting him, he was induced to put his papers into the hands of Defoe, to arrange and form them into a regular narrative. Thefe papers muft have been drawn up after he left Juan Fernandes, as he had no means of recording his tranfactions there. Captain Cooke remarks, as an extraordinary circumftance, that he had contrived to keep an account of the days of the week and month; but this might be done, as Defoe makes Robinfon Crufoe do, by cutting notches in a poft, or many other methods. From this account of Selkirk, Defoe took the idea of writing a more extenfive work, the romance of Robinfon Crufoe, and very difhoneftly defrauded the original proprietor of his fhare of the profits. Of the time or place or manner of this extraordinary man's death we have received no account; but in 1798 the cheft and mufket which Selkirk had with him on the ifland were in the poffeffion of his grand-nephew, John Selkirk weaver in Largo.

The circumftances of Selkirk's feclufion from human fociety during his ftay on Juan Fernandes, and the fentiments which that fituation naturally infpired, have been fo finely and characteriftically depicted by Mr Cowper, that many of our readers, we doubt not, will be gratified if we give the verfes alluded to a place here.

I am monarch of all I furvey,
 My right there is none to difpute;
From the centre all round to the fea,
 I am lord of the fowl and the brute.
Oh, folitude! where are the charms
 That fages have feen in thy face?
Better dwell in the midft of alarms,
 Than reign in this horrible place.
I am out of humanity's reach,
 I muft finifh my journey alone,
Never hear the fweet mufic of fpeech;
 I ftart at the found of my own.

The

Selkirk.

The beasts that roam over the plain,
My form with indifference see;
They are so unacquainted with man,
Their tameness is shocking to me.
Society, friendship, and love,
Divinely bestow'd upon man,
Oh, had I the wings of a dove,
How soon would I taste you again!
My sorrows I then might assuage
In the ways of religion and truth,
Might learn from the wisdom of age,
And be cheer'd by the sallies of youth.
Religion! what treasure untold
Resides in that heavenly word!
More precious than silver and gold,
Or all that this earth can afford.
But the sound of the church-going bell
These valleys and rocks never heard,
Ne'er sigh'd at the sound of a knell,
Or smil'd when a sabbath appear'd.
Ye winds that have made me your sport,
Convey to this desolate shore
Some cordial endearing report
Of a land I shall visit no more.
My friends, do they now and then send
A wish or a thought after me?
O tell me I yet have a friend,
Though a friend I am never to see.
How fleet is a glance of the mind!
Compar'd with the speed of its flight,
The tempest itself lags behind,
And the swift-winged arrows of light.
When I think of my own native land,
In a moment I seem to be there;
But alas! recollection at hand
Soon hurries me back to despair.
But the sea-fowl is gone to her nest,
The beast is laid down in his lair.
Ev'n here is a season of rest,
And I to my cabin repair.
There's mercy in every place;
And mercy, encouraging thought!
Gives even affliction a grace,
And reconciles man to his lot.

SELKIRK, the capital of the county of the same name, is a small town pleasantly situated on a rising ground, and enjoys an extensive prospect in all directions, especially in the course of the river Ettrick. It is remarkable for those plaintive airs produced in its neighbourhood, the natural simplicity of which are the pride of Scotland and the admiration of strangers.

The citizens of this burgh, like the other inhabitants of the sheriffdom of Ettrick forest, rendered themselves famous by adhering to the fortune of their sovereign James IV. Of 100 citizens who followed that monarch to the plains of Flodden, a few returned loaded with spoils taken from the English. Of the trophies of that day, there yet remains in the possession of the corporation of weavers, a standard taken by a member of that body. It may also be mentioned, that the sword of William Brydone, the town-clerk, who led the citizens to the battle, and was knighted for his valour, still remains, it is said, in the [illegible] citizen of Selkirk, his lineal descendent. The desperate valour of the citizens, however, so exasperated the English, that they reduced their defenceless town to ashes; but their grateful sovereign, James V. shewed his sense of their services by a grant of an extensive track of Ettrick forest, the trees for building their houses, and the property as a reward for their heroism. Selkirk is a royal burgh, uniting with Lanark, Linlithgow and Peebles, in sending a member to parliament. W. Long. 2. 46. N. Lat. 55. 26.

Selkirk || Selkirk-shire.

SELKIRK-SHIRE, called also the *Sheriffdom of Ettrick Forest*, a county of Scotland, extending about 20 miles in length from east to west, and about 12 in breadth from south to north. It borders on the north with part of Tweeddale and Mid-Lothian; on the south and east with Teviotdale; and on the west with Annandale. This county was formerly reserved by the Scottish princes for the pleasure of the chace, and where they had houses for the reception of their train. At that time the face of the country was covered with woods, in which there were great numbers of red and fallow deer, whence it had the name of *Ettrick Forest*. The woods, however, are now almost entirely cut down, and the county is chiefly supported by the breed of sheep. They are generally sold into the south, but sometimes into the Highlands, about the month of March, where they are kept during summer; and after being improved by the mountain-grass, are returned into the Lowlands in the beginning of winter.

This county, though not very populous at present, was once the nurse of heroes, who were justly accounted the bulwark of their native soil, being ever ready to brave danger and death in its defence. Of this we have a memorable proof in the pathetic lamentations of their wives and daughters for the disaster of the field of Flodden, "where their brave foresters were a' wed away." The rivers Ettrick and Yarrow unite a little above the town of Selkirk, and terminate in the Tweed. For five miles above its junction with the Etterick, the Tweed is still adorned with woods, and leads the pleased imagination to contemplate what this country must have been in former times. The Yarrow, for about five miles above its junction with Ettrick, exhibits nature in a bold and striking aspect. Its native woods still remain, through which the stream has cut its turbid course, deeply ingulphed amidst rugged rocks. Here, certainly in a flood, stood the descriptive Thomson when he saw it

Statist. Account of Scotland, vol. ii.

"Work and boil, and foam and thunder through."

On a peninsula, cut out by the surrounding stream, in the middle of this fantastically wild scene of grandeur and beauty, stand the castle of Newark, which has been supposed by many to be the birthplace of Mary Scot the flower of Yarrow.

The population of this county in 1801 amounted to 5070, but the following is the population of the different parishes at two different periods, according to the Statistical History.

Parishes.	Population in 1755.	Population in 17[illegible]—1798.
Ettrick,	397	47[illegible]
Galashiels,	998	914
Carry forward,	1395	1[illegible]84

Selkirk

Parishes.	Population in 1755.	Population in 1790—1798.
Brought over,	1395	1384
Selkirk,	1793	1700
Yarrow,	1180	1230
	4368	4314
	4314	
Decreafe,	54	

SELL, or SILL, in building, is of two kinds, viz. *Ground Sell*, denoting the loweft piece of timber in a wooden building, and that on which the whole fuperftructure is raifed; and *fell of a window* or *of a door*, which is the bottom piece in the frame of them on which they reft.

SELLA TURCICA, is a deep impreffion between the clinoid procefs of the fphenoid bone. See ANATOMY *Index*.

SELTZER WATER, is a mineral water which fprings up at Lower Seltzer, a village in the electorate of Triers, about 10 miles from Frankfort on the Mayne, and 36 from Coblentz.

Seltzer water is brought to this country in ftone bottles, which are clofely corked and fealed, and contain about 3 pints each; and when they are well fecured, it keeps unchanged for a confiderable time.

Seltzer water, according to the analyfis of Bergman, contains in an Englifh wine pint,

	grs.
Carbonate of lime	3
——— of magnefia	5
——— of foda	4
Muriate of foda	17.5
	29.5

The fame quantity of water alfo yields 17 cubic inches of a gafeous fubftance, which is found to be almoft entirely pure carbonic acid gas.

This water has been long in high repute, on account of its medical virtues, and we have no doubt that it may be ufed with confiderable benefit in many of thofe complaints which arife from a deranged ftate of the ftomach and bowels. The ufual dofe of this water is from half a pint to a pint; but in moft cafes it may be drunk freely. From its agreeable tafte, and its exhilarating effects on the fpirits, it is extenfively employed at table as a common drink in Germany and Holland. In this country alfo, both the real and artificial Seltzer water is largely ufed for the fame purpofe. Seltzer water may be artificially imitated, by adding the ingredients diluted by analyfis, and in the fame proportion.

SEM, or SHEM, the fon of Noah, memorable for his filial piety in concealing the folly and difgrace of his father, for which he received a remarkable benediction, about 2476 B. C. He lived to the age of 600 years.

Ras SEM. See *RAS Sem* and *PETRIFIED City*.

SEMECARPUS, a genus of plants belonging to the pentandria clafs. See BOTANY *Index*.

SEMEN, SEED. See BOTANY *Index*.

With refpect to number, plants are either furnifhed with one feed, as fea-pink and biftort; two, as woodroof and the umbelliferous plants; three, as fpurge; four, as the lip-flowers of Tournefort and rough-leaved plants of Ray; or many, as ranunculus, anemone, and poppy.

The form of feeds is likewife extremely various, being either large or fmall, round, oval, heart-fhaped, kidney-fhaped, angular, prickly, rough, hairy, wrinkled, fleek or fhining, black, white, or brown. Moft feeds have only one cell or internal cavity; thofe of leffer burdock, valerian, lamb's lettuce, cornelian, cherry, and febeften, have two.

With refpect to fubftance, feeds are either foft, membranaceous, or of a hard bony fubftance; as in gromwell, tamarind, and all the nuciferous plants.

In point of magnitude, feeds are either very large, as in the cocoa-nut; or very fmall, as in campanula, *ammannia*, rampions, and throat-wort.

With refpect to fituation, they are either difperfed promifcuoufly through the pulp (*femina nidulantia*), as in water-lily; affixed to a future or joining of the valves of the feed-veffel, as in the crofs-fhaped and pea-bloom flowers; or placed upon a *placenta* or receptacle within the feed veffel, as in tobacco and thorn-apple.

Seeds are faid to be naked (*femina nuda*) which are not contained in a cover or veffel: fuch are thofe of the lip and compound flowers, the umbelliferous and rough-leaved plants. Covered feeds (*femina tecta*) are contained in fome veffel, whether of the capfule, pod, berry, apple, or cherry kind.

A fimple feed is fuch as bears neither crown, wing, nor downy *pappus*; the varieties in feeds, arifing from thefe circumftances, are particularly enumerated under their refpective heads.

In affimilating the animal and vegetable kingdoms, Linnæus denominates feeds the eggs of plants. The fecundity of plants is frequently marvellous; from a fingle plant or ftalk of Indian Turkey wheat, are produced, in one fummer, 2000 feeds; of elecampane, 3000; of fun-flower, 4000; of poppy, 32,000; of a fpike of cat's tail, 10,000 and upwards: a fingle fruit, or feed-veffel, of tobacco, contains 1000 feeds; that of white poppy, 8000. Mr Ray relates, from experiments made by himfelf, that 1012 tobacco feeds are equal in weight to one grain; and that the weight of the whole quantum of feeds in a fingle tobacco plant, is fuch as muft, according to the above proportion, determine their number to be 360,000. The fame author eftimates the annual produce of a fingle ftalk of fpleenwort to be upwards of one million of feeds.

The diffemination of plants refpects the different methods or vehicles by which nature has contrived to difperfe their feeds for the purpofe of increafe. Thefe by naturalifts are generally reckoned four.

1. Rivers and running waters. 2. The wind. 3. Animals. 4. An elaftic fpring, peculiar to the feeds themfelves.

1. The feeds which are carried along by rivers and torrents are frequently conveyed many hundreds of leagues from their native foil, and caft upon a very different climate, to which, however, by degrees they render themfelves familiar.

2. Thofe which are carried by the wind, are either *winged*, as in fir-tree, trumpet-flower, tulip-tree, birch, arbor-vitæ, meadow rue, and jeffamine, and fome umbelliferous plants; furnifhed with a *pappus*, or downy crown, as in valerian, poplar, reed, fucculent fwallow-wort, cotton-tree, and many of the compound flowers; placed

placed within a winged *calyx* or ſeed-veſſel, as in ſcabious, ſea-pink, dock, dioſcorea, aſh, maple, and elm-trees, logwood and woad; or laſtly, contained within a ſwelled *calyx* or ſeed-veſſel, as in winter cherry, cucubalus, melilot, bladder-nut, fumatory, bladder-ſena, heart-ſeed, and chick-peaſe.

3. Many birds ſwallow the ſeeds of vanelloe, juniper, miſletoe, oats, millet, and other graſſes, and void them entire. Squirrels, rats, parrots, and other animals, ſuffer many of the ſeeds which they devour to eſcape, and thus in effect diſſeminate them. Moles, ants, earthworms, and other inſects, by ploughing up the earth, admit a free paſſage to thoſe ſeeds which have been ſcattered upon its ſurface. Again, ſome ſeeds attach themſelves to animals, by means of crotchets, hooks, or hairs, which are either affixed to the ſeeds themſelves, as in hound's tongue, mouſe-ear, vervain, carrot, baſtard-parſley, ſanicle, water hemp-agrimony, *arctopus* and *verbeſina*; to their calyx, as in burdock, agrimony, *rhexia*, ſmall wild bugloſs, dock, nettle, pellitory, and ſeed-wort, or to their fruit or ſeed-veſſel, as in liquorice, enchanter's nightſhade, croſs-wort, cleavers, French honey-ſuckle, and arrow-headed graſs.

4. The ſeeds which diſperſe themſelves by an elaſtic force, have that force reſident either in their *calyx*, as in oats, and the greater number of ferns; in their *pappus*, as in centaurea crupina; or in their *capſule*, as in geranium, herb-bennet, African ſpiræa, fraxinella, horſe-tail, balſam, Malabar nut, cucumber, elaterium, and male balſam apple.

SEMEN, in the animal economy. See PHYSIOLOGY and ANATOMY *Index*.

SEMEN Sanctum, or *Santonicum*. See ARTEMISIA.

SEMENDRIAH, a town of Turkey in Europe, in the province of Servia, with a good citadel. It is the capital of a ſangiacate, was taken by the Turks in 1690, and is ſeated on the Danube, in E. Long. 21. 45. N. Lat. 45. 0.

SEMENTINÆ FERIÆ, in antiquity, feaſts held annually among the Romans, to obtain of the gods a plentiful harveſt. They were celebrated in the temple of Tellus, where ſolemn ſacrifices were offered to Tellus and Ceres. Theſe feaſts were held about ſeed-time, uſually in the month of January; for, as Macrobius obſerves, they were moveable feaſts.

SEMI, a word borrowed from the Latin, ſignifying *half*; but only uſed in compoſition with other words, as in the following articles.

SEMI-Arians, in eccleſiaſtical hiſtory, a branch of the ancient Arians, conſiſting, according to Epiphanius, of ſuch as, in appearance, condemned the errors of that hereſiarch, but yet acquieſced in ſome of the principles thereof, only palliating and hiding them under ſofter and more moderate terms. Though they ſeparated from the Arian faction (ſee ARIANS), they could never be brought to acknowledge that the Son was homoouſios, that is, conſubſtantial, or of the ſame ſubſtance with the Father; they would only allow him to be homoeuſios, that is, of a like ſubſtance with the Father, or ſimilar to the Father in his eſſence, not by nature, but by a peculiar privilege.

The ſemi-arianiſm of the moderns conſiſts in their maintaining that the Son was from all eternity begotten by the *will* of the Father, contrary to the doctrine of the orthodox, who ſeem to teach that the eternal generation is *neceſſary*. Such at leaſt are the reſpective opinions of Dr Clarke and Biſhop Bull. See THEOLOGY.

SEMICIRCLE, in *Geometry*, half a circle, or that figure comprehended between the diameter of the circle and half its circumference.

SEMICOLON, in *Grammar*, one of the points or ſtops uſed to diſtinguiſh the ſeveral members of a ſentence from each other.

The mark or character of the ſemicolon is (;), and has its name as being of ſomewhat leſs effect than a colon; or as demanding a ſhorter pauſe.

The proper uſe of the ſemicolon is to diſtinguiſh the conjunct members of a ſentence. Now, by a conjunct member of a ſentence is meant ſuch a one as contains at leaſt two ſimple members.—Whenever, then, a ſentence can be divided into ſeveral members of the ſame degree, which are again diviſible into other ſimple members, the former are to be ſeparated by a ſemicolon. For inſtance: "If fortune bear a great ſway over him, who has nicely ſtated and concerted every circumſtance of an affair; we muſt not commit every thing, without reſerve, to fortune, leſt ſhe have too great a hold of us." Again: *Si quantum in agro locisque deſertis audacia poteſt, tantum in foro atque judiciis impudentia valeret; non minus in cauſa cederet Aulus Cæcinna Sexta Æbutii impudentiæ, quam tum in vi facienda ceſſit audaciæ.* An inſtance in a more complex ſentence we have in Cicero: *Res familiaris primum bene parta ſit, nulloque turpi quæſtu: tum quam plurimis, modo dignis, ſe utilem præbeat; deinde augeatur ratione, diligentia, parſimonia; nec libidini potius luxuriæque, quam liberalitati et beneficentiæ pareat.*

But though the proper uſe of the ſemicolon be to diſtinguiſh conjunct members, it is not neceſſary that all the members thus divided be conjunct. For upon dividing a ſentence into great and equal parts, if one of them be conjunct, all thoſe other parts of the ſame degree are to be diſtinguiſhed by a ſemicolon.—Sometimes alſo it happens, that members that are oppoſite to each other, but relate to the ſame verb, are ſeparated by a ſemicolon. Thus Cicero: *Ex hac parte pudor, illinc petulantia; hinc fides, illinc fraudatio; hinc pietas, illinc ſcelus*, &c. To this likewiſe may be referred ſuch ſentences, where the whole going before, the parts follow as "The parts of oratory are four; invention, diſpoſition, elocution, and pronunciation."

SEMICUBIUM, in *Medicine*, an half-bath, wherein the patient is only placed up to the navel.

SEMIDIAMETER, half the diameter, or a right line drawn from the centre of a circle or ſphere to its circumference: being the ſame with what is otherwiſe called the *radius*.

SEMIFLOSCULUS, in *Botany*, a term uſed to expreſs the flowers of the ſyngeneſia claſs. Theſe ſemifloſculi are petals, hollow in their lower part, but in their upper flat, and continued in the ſhape of a tongue.

SEMITONE, in *Muſic*. See INTERVAL.

SEMINAL, ſomething belonging to the ſemen or ſeed.

SEMINARY, in its primary ſenſe, the ground where any thing is ſown, to be afterwards tranſplanted.

SEMINARY, in a figurative ſenſe, is frequently applied to places of education, whence ſcholars are tranſplanted into life.—In Catholic countries it is particularly used for a kind of college or school, where youth are instructed in the ceremonies, &c. of the sacred ministry. Of these there are great numbers; it being ordained by the council of Trent, that there be a seminary belonging to each cathedral, under the direction of the bishop.

SEMINATION, denotes the manner or act of shedding and dispersing the seeds of plants. See SEMEN.

SEMIPELAGIANS, in *Ecclesiastical History*, a name given to such as retain some tincture of Pelagianism. See PELAGIANS.

The doctrines of this sect, as well as those of their predecessors the Pelagians, have their common source in Pelagius, a native of Britain, of whom we have already taken notice. He is said to have been but a simple monk, and not in orders. Having gone to Rome about the end of the fourth century, he lived there for some years with reputation, and was considered both pious and virtuous. Rufinus a priest of Aquileia, having come to Rome in the year 397, is affirmed by some to have been the person who suggested to Pelagius his peculiar doctrines.

In the year 400 Pelagius began to teach his opinions at Rome, both by speech and writing. He was not the only person who taught these doctrines, of which we have elsewhere enumerated the heads. His friend and companion Celestius, an abler man than himself, maintained them likewise, and with much more address and subtlety. After having promulgated them in Rome, they went into Sicily, where they lived for some time. Thence, in the year 411, they passed over into Africa. Pelagius soon after went into Palestine, whilst Celestius remained at Carthage, and was preparing himself to take the order of priesthood; but it being soon discovered that he taught a new doctrine *, he was accused by the deacon Paulinus in a synod held at Carthage in 412, at which Aurelius the bishop presided. Celestius, on being charged by Paulinus with denying original sin, made answer, "That in truth he doubted whether the sin of Adam was transmitted to his posterity." He did not however own that children had no need of baptism, although this was one of the Pelagian tenets: on the contrary, he wrote a little discourse, in which he acknowledged, that children had need of redemption, and that they could not obtain it without baptism. The bishops at the council of Carthage condemned the doctrines of Celestius, and excommunicated him. From this sentence he appealed to the bishop of Rome; but he neglected to pursue his appeal, and went to Ephesus, where he endeavoured to get himself ordained priest. In the mean time, Pelagius having retired into Palestine, was kindly received by St Jerome's enemy, John of Jerusalem. With him he entered into an engagement to attack the reputation of that author. St Jerome defended himself from their fault, and attacked the doctrine of Pelagius †, and in this undertaking he was then assisted by St Austine. About this time, Orosius having come from Spain into Africa and thence into Palestine, published there the proceedings against Celestius at Carthage, and was present at a council by the bishop of Jerusalem wherein he held a conference with Pelagius in his presence; and the bishop having shown too much partiality for Pelagius, Orosius would not acknowledge him for judge, but demanded that the decision of that affair, which was among the Latins, might be referred to judges who understood the language. This happened in the year 415, at which time there were in Palestine two French prelates, who, being driven from their dioceses, fled into that country, and having been apprized of the opinions of Pelagius and Celestius, drew up an abridgement from their own books of the errors imputed to them ‡. To this they joined the articles condemned in the synod of Carthage, and some others, which were sent from Sicily by Hilarius to St Augustine, and then presented the abridgement to the bishop of Cæsarea. The matter was referred to a council of 14 bishops, at which, when the memoir was read, Pelagius explained himself upon some articles, and denied that he was the author of others. He also disowned the propositions condemned at Carthage, and some others ascribed to Celestius. He did not even hesitate to condemn them; upon which the bishops decided, that, since Pelagius approved the doctrine of the church, and rejected and condemned what was contrary to its belief, they acknowledged him to be of the ecclesiastical and catholic communion.

Orosius returning to Africa, took with him the memoir against Pelagius, and presented it to a meeting of bishops * held at Carthage in 416. Having read over what had been done at a former meeting against Celestius, they declared, that both he and Pelagius ought to be anathematized if they did not publicly renounce and condemn the errors imputed to them. The bishops of this meeting, and those of Numidia assembled the same year at Milivetum, wrote upon the subject to Pope Innocent, who approved of the judgement of the African prelates, and declared Pelagius, Celestius, and their followers excommunicated †. Innocent gave an account of this judgement to the bishops of the East, and the matter seemed altogether at an end, when he died; but Celestius having been made priest at Ephesus, and having gone to Constantinople, whence he was driven by Atticus bishop of that city, who also wrote against him to Asia and to Africa, he came to Rome in the beginning of the pontificate of Zozimus, and undertook to pursue the appeal, which he had formerly made from the judgement of the synod of Carthage. Having cited his accuser Paulinus, and offered to justify himself, he presented a Confession of Faith, in which he acknowledged that children ought to be baptized, in order to inherit the kingdom of heaven; but he denied that the sin of Adam was transmitted to his children. He appeared before the bishops and clergymen assembled by the pope, and declared, that he condemned all the errors with which he had been charged. The pope delayed his judgement for two months, and in the mean time received a letter and a confession of faith from Pelagius, very artfully drawn up. When the time for judgement arrived, Zozimus held a synod, and said, that he thought the declarations of Pelagius and Celestius sufficient for their justification. He was displeased at the two French bishops for not appearing against them, and wrote two letters on that head, one to the bishops of Africa, and another in particular to Aurelius, bishop of Carthage. The African bishops, to the number of 214, without regarding the judgement passed at Rome, assembled at Carthage, and, having confirmed their former decisions, condemned the doctrines of the Pelagians. They wrote to

Seminaries, & Semipelagians.

Semipelagians.

* August. de Gratia.

† ... and Apology of Orosius.

‡ St Austine on Original Sin, and against the Pelagians.

* The Epistles of St Augustine.

† Marius Mercator's Commentary.

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to the biſhop of Reme to acquaint him, that he had been deceived by Celeſtius, and diſcovered to him the equivocations of his letter and of the Confeſſion of Faith of Pelagius, ſending him a memoir of the errors of which he ſhould require a diſtinct and preciſe revocation from the two heretics. The pope made anſwer, that, although his authority was ſo great, that none durſt diſſent from his judgement, ſtill that he was willing to communicate the matter to them, and would let it remain in the ſame ſtate, until a new deliberation could take place. This letter was preſented to a council held at Carthage in 418, at which eight canons were drawn up againſt the Pelagian hereſy. The biſhop of Rome, in the mean time, was inclined to examine again the affair of Celeſtius, and to endeavour to draw from him diſtinct and preciſe anſwers according to the plan ſuggeſted by the African biſhops in their memoir; but Celeſtius would not come forward, and accordingly withdrew from Rome. From his flight the pope concluded, that he impoſed upon him formerly, and that he held the new doctrines; and, accordingly, changing his opinion with reſpect to him, he approved of the decrees of the African prelates, and renewed the condemnations of his predeceſſor, Pope Innocent, againſt him and Pelagius *. This judgement he publiſhed in a letter which was ſent to all the biſhops. About the ſame time an edict was publiſhed by the emperor Honorius againſt Pelagius and Celeſtius, ordering, that they ſhould be baniſhed from Rome, and that all their followers ſhould be ſent into exile.

* See *the Letters of St Auguſtine.*

In the following year Honorius publiſhed another edict, by which it was ordered, that the biſhops who would not ſign the pope's letter, ſhould be deprived of their churches. Accordingly, Julian the biſhop of Eclana, who was afterwards head of the party, and ſeventeen other biſhops, were caſhiered; upon which they wrote a letter to Rufus, biſhop of Theſſalonica, and demanded a univerſal council from the emperor, which he refuſed. Celeſtius returned again to Rome, but was again expelled the city; whilſt his followers, being expelled from Italy, retired to different countries. Some of them came over into Britain, and others went into the Eaſt. Atticus baniſhed them from Conſtantinople, and they were alſo baniſhed from Epheſus. Theodotus, biſhop of Antioch, condemned them in a ſynod held at Dioſpolis, and baniſhed Pelagius and his followers out of Paleſtine, whither they had returned. Julian the biſhop was condemned in a provincial ſynod of Cilicia, whither he had retired to Theodorus biſhop of Mopſueſta, who was obliged to anathematize him. What became of Pelagius is unknown, as hiſtory gives no farther account of him; but Celeſtius having returned to Rome, and being driven thence by Pope Celeſtin, went with Julian and ſome other biſhops of their party to Conſtantinople, where they endeavoured to prevail upon the emperor Theodoſius to aſſemble a council, inſtead of which he ordered them to leave the city. After this they joined with the Neſtorians †, and were condemned together with them in a general council held at Epheſus in 431; and there now remained but a ſmall number of Pelagians diſperſed in the Weſt. Julian after having endeavoured ſeveral times to get himſelf reinſtated in his biſhopric, was at laſt obliged to retire into Sicily, where he died.

† *Proſper in his Chronicle.*

To the Pelagians ſucceeded the Semipelagians, who rejected the doctrines of the former with reſpect to original ſin and the power of free will to do good ‡. They owned, that man had need of the grace of God to perſevere in well-doing; but they believed, that the beginning of good will and faith did not neceſſarily depend upon grace; for that man, by the mere force of nature, might deſire to do good, and that God ſeconded that good will by his aſſiſtance, which depended upon liberty, and was given to all men. Beſides theſe, they maintained ſome other peculiar tenets. The origin of ſome of their opinions is founded in this, that ſome of the books which were written by St Auguſtine in his laſt years, with reſpect to the controverſies which aroſe in the monaſtery of Adrumetum, relative to correction, grace, and predeſtination, having been carried into Gaul, happened to give offence to ſeveral perſons, and particularly to the monks of Lerins, who conſidered his doctrines hoſtile to that of free will. This led them to think and to maintain, that, in order to be ſaved, it was neceſſary to leave to man the power of knowing and deſiring good by the force of nature, ſo that the beginning might come from man. Several conſiderable perſons in Gaul, and even ſome biſhops, but particularly the prieſts, were of this opinion. Caſſian, deacon of Conſtantinople, and afterwards prieſt at Marſeilles, authorized it in his conferences, and Fauſtus, biſhop of Riez, ſupported it very ſtrenuouſly. St Auguſtine ſtood up to oppoſe this doctrine from its very firſt appearance, and was ſupported by Proſper and Hilarius. Pope Celeſtin complained to the biſhops of Gaul, that they ſuffered their prieſts to ſpeak ill of the doctrines of St Auguſtine; and Popes Gelaſius and Hormiſdas condemned the books of Fauſtus; and laſt of all, the council of Orange, held in 529, condemned particularly the principal tenets of the Semipelagians, and put an end at that time to the controverſy, about 100 years after the death of St Auguſtine.—See the hiſtories of Moſheim, Dupin and Fleury, &c. &c.

‡ *Hilary's Letters to Auguſtine.*

The Semipelagians were very numerous; and their doctrines, though variouſly explained, were received in many of the monaſtic ſchools in Gaul, whence they ſpread themſelves far and wide through Europe. With reſpect to the Greeks and other Chriſtians of the Eaſt, we may remark, that they had adopted the Semipelagian tenets, even before they were promulgated in Gaul by Caſſian and Fauſtus.

After the period, however, at which the Semipelagian doctrines were condemned in the council of Orange, we find but little notice taken of this ſect by hiſtorians. Although its tenets were maintained by a few in the ſucceeding centuries, the ſect could boaſt of no eminent leaders, and ſunk into obſcurity. In the beginning, indeed, of the reformation, ſome of the Pelagian tenets were again brought into circulation. Every one is acquainted with the hoſtility of Luther to the doctrine of free will, who went ſo far into the oppoſite extreme as to entitle one of his works againſt the celebrated Eraſmus on this ſubject, "*De Servo Arbitrio.*" But notwithſtanding that Luther was their leader, this doctrine of his was not adopted by ſome of the moſt eminent of the reformers. His learned friend, the mild and worthy Melancthon, although he at firſt (either from not having ſufficiently conſidered the ſubject, or becauſe this doctrine was ſo unpalatable to the great body of the reformers on account of the authority of Luther), joined with

Semipelagians.

with Luther in his hostility to the doctrine of free will, so far as to say, that free will could have no effect, under the influence of grace, shortly after changed his opinion so as to run into the opposite extreme. For although Luther at his outset had affirmed, that the prescience of God annihilated free will in all his creatures, he was so softened down into moderation at the time of the drawing up of the famous Confession of Augsburg, as to allow Melancthon, who composed it, to insert these words, "that it was necessary to allow free-will to all who possessed the use of reason, not however in such things as regarded God, which they could not commence, *or at least which they could not complete*, without his assistance and grace, but in the affairs, or works, of the present life solely, and in order to perform their duty towards society *." In this passage two truths are clearly admitted: 1. That there is free-will in man; and 2. That of itself it has no efficacy in such works as are purely Christian or religious. But although this be evident, and although it would seem as if he attributed the efficacy of religious works solely to the grace of God, yet the restricting words "*at least*," show, that he was of opinion, that free-will, by its own natural force and efficacy, though it could not complete, *could at least commence*, Christian or religious works, without the assistance of grace. To such of our readers as are acquainted with ecclesiastical history, it is unnecessary to remark, that this was one of the leading tenets of the Semipelagians. But Melancthon did not stop here. It is true, that, in order to keep well with the reformers, he was obliged, in those public instruments which he drew up, to insinuate rather than avow his partiality for the doctrine of free-will, the exercise of which, we see, he confined in the Confession of Augsburg to such actions merely as regarded civil life and our duties to society. In the Saxon Confession of Faith, however, he proceeds a step farther, and says "that the will is free: that God neither wishes for, nor approves, nor co-operates in the production of sin; but that the free-will of man and of the devils is the true cause of their sin and of their fall." Many no doubt will be of opinion, that Melancthon merits praise for having thus corrected Luther, and for having more clearly expressed his own opinion, than he had done in the Confession of Augsburg. He even proceeds farther, and extends the exercise of free-will to religious or Christian works. For after having explained in the Saxon Confession of Faith the nature of free-will, and the manner in which it makes a choice, and having also shown, that it is not of itself sufficient in those works, or actions, which regard a future life, he affirms twice "that the will, even after having received the influence of the Holy Spirit, does not remain idle," that is to say, it is not merely passive under the influence of grace, but can reject it, or co-operate with it, at pleasure. Necessity, it is true, obliged him to express his opinion rather obscurely. But what he insinuates only in these last quoted words, is clearly and fully expressed in one of his letters to Calvin. "I had, says he, a friend who, in reasoning upon predestination, believed equally the two following things; namely, that every thing happens amongst men as it is ordained by Providence, but that there is, nevertheless, a contingency in actions or in events. He confessed, however, that he was unable to reconcile these two things. For my part, (continues Melancthon), who am of opinion, that God neither wishes for, nor is the cause of sin, I acknowledge this contingency in the feebleness of our judgement, in order that the ignorant may confess, that David fell of himself, and voluntarily, into sin; that he had it in his power to preserve the grace of the Holy Spirit which he had within him, and that in this combat, or trial, it is necessary to acknowledge some exercise or action of the will *". This opinion he confirms and illustrates by a passage from St Basil, where he says, "Have but the will, or the inclination, and God is with you." By which words Melancthon seems to insinuate, that the will is not only active in the works of religion, but even begins them without grace. This, however, was not the meaning of St Basil, as is evident from several other parts of his writings; but that it was the opinion of Melancthon appears fully from this passage, as well as from that which we have cited from the Confession of Augsburg, in which he insinuates, that the error is not in saying, that the will can of itself commence, but in thinking, that it can without grace finish or complete, religious or Christian works. Thus it appears, that he considered the will capable of rejecting the influence of grace, since he declares, that David could preserve the Holy Spirit when he lost it, as well as he could lose it when he kept it within him. But although this was his decided opinion, he durst not avow it fully in the Saxon Confession of Faith, but was obliged to content himself with insinuating it gently in these words, "The will, even after receiving the grace of the Holy Spirit, is not idle or without action." All this precaution, however, was insufficient to save Melancthon from censure. Francowitz, better known by the name of Illyricus, being jealous of him and his enemy, by his influence with his party procured the condemnation of these words of the Saxon Confession, and of the passage from St Basil, at two synods held by the Reformers; at the same time, that one party of the Lutherans were unwilling to adopt Melancthon's opinion, "that the will is not passive, when under the influence of grace," we are at a loss to think how they could deny it, since they almost unanimously confess, that a person under the influence of grace may reject and lose it. This opinion is avowed in the Confession of Augsburg and in Melancthon's Apology. It was even, long after that, decided upon anew, inculcated strongly in their book of Concord, and was brought frequently against them by their opponents as a proof of inconsistency and contradiction.

These are not the only instances in which the Lutherans were charged with Semipelagian principles. One of the ablest and the most learned of their opponents, we cannot help thinking, had in more than one instance made good the charge against them. To prove this we need only refer to the remarks that have been made on the eight celebrated propositions in the third book of Concord, relative to the co-operation of the will with grace. According to the first seven of these propositions, an attentive listening to the preaching of the word of God produceth grace; and according to the fifth, any man, even a libertine or an infidel, is free, or has it in his power to listen attentively to the preaching of the word of God. He has it then in his power to give to himself that which to him is productive of grace, and may thus be the sole author of his own conversion or

* See the 18th article, and Melancthon's Apology.

* See Calvin's Letters.

Semipelagians, Semiramis.

or regeneration. In the eighth propoſition it is affirmed, that we are not permitted to doubt, but that the grace of the Holy Spirit, even though it may not be felt, does accompany an attentive hearing of the word of God; and to do away every doubt about the ſpecies of attention which they mean, we muſt obſerve, that they ſpeak of attention in as much as it precedes the grace of the Holy Spirit, and of that attention which, in conſequence of its dependence on free-will, we have it in our power to beſtow upon the word or not, juſt as we pleaſe. It is the exerciſe of this free attention which they ſay operates grace. But here it would ſeem, that they were in extremes; for, as they ſaid upon one hand, that, when the Holy Spirit begins to move us, we act not at all; ſo they maintained on the other, that this operation of the Holy Spirit, which converts us without any co-operation on our part, is neceſſarily attendant upon an act of our wills, in which the Holy Spirit has no ſhare, and in which our liberty acts purely by its natural force or power. Such of our readers as are anxious to examine the progreſs of the Pelagian and Semipelagian principles after the dawn of the Reformation, we muſt refer to the works of the principal reformers and to thoſe of their adverſaries, as well as to the different writers upon eccleſiaſtical hiſtory.

SEMIRAMIS, in fabulous hiſtory, a celebrated queen of Aſſyria, daughter of the goddeſs Derceto, by a young Aſſyrian. She was expoſed in a deſert; but her life was preſerved by doves for one whole year, till Simmas, one of the ſhepherds of Ninus, found her and brought her up as his own child. Semiramis, when grown up, married Menones, the governor of Nineveh, and accompanied him to the ſiege of Bactria; where, by her advice and prudent directions, ſhe haſtened the king's operations, and took the city. Theſe eminent ſervices, together with her uncommon beauty, endeared her to Ninus. The monarch aſked her of her huſband, and offered him his daughter Soſana in her ſtead; but Menones, who tenderly loved Semiramis, refuſed; and when Ninus had added threats to entreaties, he hanged himſelf. No ſooner was Menones dead, than Semiramis, who was of an aſpiring ſoul, married Ninus, by whom ſhe had a ſon called *Ninyas*. Ninus was ſo fond of Semiramis, that at her requeſt he reſigned the crown, and commanded her to be proclaimed queen and ſole empreſs of Aſſyria. Of this, however, he had cauſe to repent: Semiramis put him to death, the better to eſtabliſh herſelf on the throne; and when ſhe had no enemies to fear at home, ſhe began to repair the capital of her empire, and by her means Babylon became the moſt ſuperb and magnificent city in the world. She viſited every part of her dominions, and left everywhere immortal monuments of her greatneſs and benevolence. To render the roads paſſable and communication eaſy, ſhe hollowed mountains and filled up valleys, and water was conveyed at a great expence by large and convenient aqueducts to barren deſerts and unfruitful plains. She was not leſs diſtinguiſhed as a warrior: Many of the neighbouring nations were conquered; and when Semiramis was once told as ſhe was dreſſing her hair, that Babylon had revolted, ſhe left her toilette with precipitation, and though only half dreſſed, ſhe refuſed to have the reſt of her head adorned before the ſedition was quelled and tranquillity re-eſtabliſhed. Semiramis has been accuſed of licentiouſneſs; and ſome authors have obſerved that ſhe regularly called the ſtrongeſt and handſomeſt men in her army to her arms, and afterwards put them to death, that they might not be living witneſſes of her incontinence. Her paſſion for her ſon was alſo unnatural; and it was this criminal propenſity which induced Ninyas to deſtroy his mother with his own hands. Some ſay that Semiramis was changed into a dove after death, and received immortal honours in Aſſyria. It is ſuppoſed that ſhe lived about 11 centuries before the Chriſtian era, and that ſhe died in the 62d year of her age and the 25th of her reign. Many fabulous reports have been propagated about Semiramis, and ſome have declared that for ſome time ſhe diſguiſed herſelf and paſſed for her ſon Ninyas. *Lempriere's Bibliotheca Claſſica.*

Semiramis, Senate.

SEMPERVIVUM, HOUSE LEEK, a genus of plants belonging to the claſs dodecandria; and in the natural method ranking under the 13th order, *Succulentæ*. See BOTANY *Index*.

SENAAR, or SENNAAR. See SENNAAR.

SENATE, in general, is an aſſembly or council of ſenators; that is, of the principal inhabitants of a ſtate, who have a ſhare in the government.

The ſenate of ancient Rome is of all others the moſt celebrated. It exerciſed no contentious juriſdiction; but appointed judges, either from among the ſenators or knights, to determine proceſſes: it alſo appointed governors of provinces, and diſpoſed of the revenues of the commonwealth, &c. Yet did not the whole ſovereign power reſide in the ſenate, ſince it could not elect magiſtrates, make laws, or decide of war and peace; in all which caſes the ſenate was obliged to conſult the people.

The ſenate, when firſt inſtituted by Romulus, conſiſted of 100 members; to whom he afterwards added the ſame number when the Sabines had migrated to Rome. Tarquin the ancient made the ſenate conſiſt of 300, and this number remained fixed for a long time; but afterwards it fluctuated greatly, and was increaſed firſt to 700, and afterwards to 900 by Julius Cæſar, who filled the ſenate with men of every rank and order. Under Auguſtus the ſenators amounted to 1000, but this number was reduced, and fixed to 600. The place of a ſenator was always beſtowed upon merit: the monarchs had the privilege of chooſing the members; and after the expulſion of the Tarquins, it was one of the rights of the conſuls, till the election of the cenſors, who from their office ſeemed moſt capable of making choice of men whoſe character was irreproachable, whoſe morals were pure, and relations honourable. Only particular families were admitted into the ſenate; and when the plebeians were permitted to ſhare the honours of the ſtate, it was then required that they ſhould be born of free citizens. It was alſo required that the candidates ſhould be knights before their admiſſion into the ſenate. They were to be above the age of 25, and to have previouſly paſſed through the inferior offices of quæſtor, tribune of the people, edile, pretor, and conſul.

The ſenate always met of courſe on the 1ſt of January, for the inauguration of the new conſuls; and in all months, univerſally, there were three days, viz. the kalends, nones, and ides, on which it regularly met: but it always met on extraordinary occaſions, when called together by conſul, tribune, or dictator.

To render their decrees valid and authentic, a certain number of members was requiſite, and ſuch as

 were

were abſent without ſome proper cauſe were always fined. In the reign of Auguſtus, 400 ſenators were requiſite to make a ſenate. Nothing was tranſacted before ſunriſe or after ſunſet. In their office the ſenators were the guardians of religion, they diſpoſed of the provinces as they pleaſed, they prorogued the aſſemblies of the people, they appointed thankſgivings, nominated their ambaſſadors, diſtributed the public money, and in ſhort had the management of every thing political or civil in the republic, except the creating of magiſtrates, the enacting of laws, and the declaration of war or peace, which were confined to the aſſemblies of the people.

SENATOR, in general, denotes a member of ſome ſenate.

The dignity of a Roman ſenator could not be ſupported without the poſſeſſion of 80,000 ſeſterces, or about 7000l. Engliſh money; and therefore ſuch as ſquandered away their money, and whoſe fortune was reduced below this ſum, were generally ſtruck out of the liſt of ſenators. This regulation was not made in the firſt ages of the republic, when the Romans boaſted of their poverty. The ſenators were not permitted to be of any trade or profeſſion. They were diſtinguiſhed from the reſt of the people by their dreſs; they wore the laticlave, half boots of a black colour, with a creſcent or ſilver buckle in the form of a C; but this laſt honour was confined only to the deſcendants of thoſe hundred ſenators who had been elected by Romulus, as the letter C ſeems to imply. See the preceding article.

Among us, ſenator is a member of parliament. In the laws of King Edward the Confeſſor, we are told that the Britons called thoſe *ſenators* whom the Saxons called afterwards *aldermen* and *borough-maſters*; though not for their age, but their wiſdom; for ſome of them were young men, but very well ſkilled in the laws. Kenulph king of the Mercians granted a charter, which ran thus, viz. *Conſilio et conſenſu* epiſcoporum *et* ſenatorum *gentis ſuæ largitus fuit dicto monaſterio*, &c.

In Scotland, the lords of ſeſſion are called *ſenators* of the college of juſtice.

SENATUS AUCTORITAS. See the next article.

SENATUS-Conſultum, which made part of the Roman law. When any public matter was introduced into the ſenate, which was always called *referre ad ſenatum*, any ſenator whoſe opinion was aſked, was permitted to ſpeak upon it as long as he pleaſed, and on that account it was often uſual for the ſenators to protract their ſpeeches till it was too late to determine. When the queſtion was put, they paſſed to the ſide of that ſpeaker whoſe opinion they approved, and a majority of votes was eaſily collected, without the trouble of counting the numbers. When the majority was known, the matter was determined, and a *ſenatus conſultum* was immediately written by the clerks of the houſe, at the feet of the chief magiſtrates, and it was ſigned by all the principal members of the houſe. When there was not a ſufficient number of members to make a ſenate, the deciſion was called *ſenatus auctoritas*, but it was of no force if it did not afterwards paſs into a *ſenatus conſultum*.

The *ſenatus conſulta* were at firſt left in the cuſtody of the kings, and afterward of the conſuls, who could ſuppreſs or preſerve them; but about the year of Rome 304, they were always depoſited in the temple of Ceres, and afterwards in the treaſury, by the ediles of the people.

SENECA, Lucius Annæus, a Stoic philoſopher, was born at Corduba in Spain, about the beginning of the Chriſtian era, of an equeſtrian family, which had probably been tranſplanted thither in a colony from Rome. He was the ſecond ſon of Marcus Annæus Seneca, commonly called the *rhetorician*, whoſe remains are printed under the title of *Suaſoriæ et Controverſiæ, cum Declamationum Excerptis*; and his youngeſt brother Annæus Mela (for there were three of them) had the honour of being father to the poet Lucan. He was removed to Rome, together with his father and the reſt of his family, while he was yet in his infancy. There he was educated in the moſt liberal manner, and under the beſt maſters. He learned eloquence from his father; but his genius rather leading him to philoſophy, he put himſelf under the ſtoics Attalus, Sotion, and Papirius Fabianus; men famous in their way, and of whom he has made honourable mention in his writings. It is probable, too, that he travelled when he was young, ſince we find him, in ſeveral parts of his works, particularly in his *Quæſtiones Naturales*, making very exact and curious obſervations upon Egypt and the Nile.—But this, though entirely agreeable to his own humour, did not at all correſpond with that ſcheme or plan of life which his father had drawn out for him; who, therefore, forced him to the bar, and put him upon ſoliciting for public employments; ſo that he afterwards became quæſtor, prætor, and, as Lipſius will have it, even conſul.

In the firſt year of the reign of Claudius, when Julia the daughter of Germanicus was accuſed of adultery by Meſſalina, and baniſhed, Seneca was baniſhed too, being charged as one of the adulterers. Corſica was the ſeat of his exile, where he lived eight years; "happy in the midſt of thoſe things which uſually make other people miſerable;" *inter eas res beatus, quæ ſolent miſeros facere*: and here he wrote his books of conſolation, addreſſed to his mother Helvia, and to his friend Polybius, and perhaps ſome of thoſe tragedies which go under his name; for he ſays, *modo ſe levioribus ſtudiis ibi oblectaſſe*. Agrippina being married to Claudius, upon the death of Meſſalina, ſhe prevailed with the emperor to recal Seneca from baniſhment; and afterwards procured him to be tutor to her ſon Nero, whom ſhe deſigned for the empire. Africanus Burrhus, a prætorian præfect, was joined with him in this important charge: and theſe two preceptors, who were entruſted with equal authority, had each his reſpective department. By the bounty and generoſity of his royal pupil, Seneca acquired that prodigious wealth which rendered him in a manner equal to kings. His houſes and walks were the moſt magnificent in Rome. His villas were innumerable: and he had immenſe ſums of money placed out at intereſt in almoſt every part of the world. The hiſtorian Dio reports him to have had 250,000l. ſterling at intereſt in Britain alone; and reckons his calling it in all at a ſum, as one of the cauſes of a war with that nation.

All this wealth, however, together with the luxury and effeminacy of a court, does not appear to have had any ill effect upon the temper and diſpoſition of Seneca. He continued abſtemious, exact in his manners, and, above all, free from the vices fo commonly prevalent in fuch places, flattery and ambition. "I had rather (faid he to Nero) offend you by fpeaking the truth, than pleafe you by lying and flattery: *maluerim veris offendere, quam placere adulando*." How well he acquitted himfelf in quality of preceptor to his prince, may be known from the five firft years of Nero's reign, which have always been confidered as a perfect pattern of good government; and if that emperor had but been as obfervant of his mafter through the whole courfe of it, as he was at the beginning, he would have been the delight, and not, as he afterwards proved, the curfe and deteftation of mankind. But when Poppæa and Tigellinus had got the command of his humour, and hurried him into the moft extravagant and abominable vices, he foon grew weary of his mafter, whofe life muft indeed have been a conftant rebuke to him. Seneca, perceiving that his favour declined at court, and that he had many accufers about the prince, who were perpetually whifpering in his ear the great riches of Seneca, his magnificent houfes and fine gardens, and what a favourite through means of thefe he was grown with the people, made an offer of them all to Nero. Nero refufed to accept them: which, however, did not hinder Seneca from changing his way of life; for, as Tacitus relates, he "kept no more levees, declined the ufual civilities which had been paid to him, and, under a pretence of indifpofition, or fome engagement or other, avoided as much as poffible appearing in public."

Nero, in the mean time, who, as it is fuppofed, had difpatched Burrhus by poifon, could not be eafy till he had rid himfelf of Seneca alfo: For Burrhus was the manager of his military concerns, and Seneca conducted his civil affairs. Accordingly, he attempted, by means of Cleonicus, a freedman of Seneca, to take him off by poifon; but this not fucceeding, he ordered him to be put to death, upon an information that he was privy to Pifo's confpiracy againft his perfon. Not that he had any real proof of Seneca's being concerned in this plot, but only that he was glad to lay hold of any pretence for deftroying him.—He left Seneca, however, at liberty to choofe his manner of dying; who caufed his veins to be opened immediately. His wife Paulina, who was very young in comparifon of himfelf, had yet the refolution and affection to bear him company, and thereupon ordered her veins to be opened at the fame time; but as Nero was not willing to make his cruelty more odious and infupportable than there feemed occafion for, he gave orders to have her death prevented: upon which her wounds were bound up, and the blood ftopped, in juft time enough to fave her; though, as Tacitus fays, fhe looked fo miferably pale and wan all her life after, that it was eafy to read the lofs of her blood and fpirits in her countenance. In the mean time, Seneca, finding his death flow and lingering, defired Statius Annæus his phyfician to give him a dofe of poifon, which had been prepared fome time before in cafe it fhould be wanted; but this not having its ufual effect, he was carried to a hot bath, where he was at length ftifled with the fteams. He died, as Lipfius conjectures, in the 63d or 64th year of his age, and in about the 10th or 11th of Nero's reign. Tacitus, on mentioning his death, obferves, that, as he entered the bath, he took of the water, and with it fprinkled fome of his neareft domeftics, faying, "That he offered thofe libations to Jupiter the Deliverer." Thefe words are an evident proof that Seneca was not a Chriftian, as fome have imagined him to have been; and that the 13 epiftles from Seneca to St Paul, and from St Paul to Seneca, are fuppofititious pieces. His philofophical works are well known.—They confift of 124 *epiftles* and diftinct treatifes; and, except his books of phyfical queftions, are chiefly of the moral kind, treating of anger, confolation, providence, tranquillity of mind, conftancy, clemency, the fhortnefs of life, a happy life, retirement, benefits. He has been juftly cenfured by Quintilian and other critics, as one of the firft corrupters of the Roman ftyle; but his works are highly valuable, on account of the vaft erudition which they difcover, and the beautiful moral fentiments which they contain.

SENECIO, GROUNDSEL; a genus of plants belonging to the clafs fyngenefia, and to the order of polygamia fuperflua; and in the natural method ranking under the 49th order, *Compofitæ*. See BOTANY *Index*.

SENEGAL, a part of Negroland in Africa, the boundaries of which are not known. See GUINEA.

Ifle of SENEGAL, fometimes called *Saint Louis*, is a fmall ifland in the mouth of the river Senegal, and according to Mafkelyne's tables is fituated in N. Lat. 15. 53. W. Long. 16. 31. The Dutch were the firft Europeans who fettled at Senegal; but their colony was expelled by the French in 1687. It was taken by the Englifh in 1692; and retaken by the French the year following. It was a fecond time taken poffeffion of by the Englifh in 1758; but in 1779 the French recovered it, and it was ceded by the Britifh crown by the treaty of 1783.

The beft account of this ifland which we have feen, is given in the interefting voyage of M. Saugnier to the coaft of Africa. This adventurer vifited Senegal in June 1785.

"The ifland (fays he), properly fpeaking, is only a bank of fand in the middle of the river. It is 1000 geometrical paces long, and about 60 in its greateft width; is almoft on a level with the river and with the fea, being defended from the latter by Barbary point, which is of greater elevation than the colony. The eaftern branch of the river is the more confiderable of the two, being about 400 toifes acrofs; the weftern branch is only from 50 to 200 toifes wide. The ifle confifts entirely of burning fands, on the barren furface of which you fometimes meet with fcattered flints, thrown out among their ballaft by veffels coming from Goree, or with the ruins of buildings formerly erected by Europeans. There is fcarcely fuch a thing as a garden upon the ifland; European feeds in general not thriving here. It is not furprifing that the foil is fo unproductive; for the air is ftrongly impregnated with fea falt, which pervades every thing, and confumes even iron in a very fhort fpace of time. The heats are exceffive, and rendered ftill more infupportable by the reflection of the fand; fo that from ten in the morning until four in the afternoon it is almoft impoffible to do any work. During the months of January, February, March, and April, the heats are moderated; but in Auguft and the following months they become fo oppreffive as even to affect the natives themfelves. What effect then muft they have upon the Europeans, fuddenly tranfported into this burning climate? The nights are a little lefs fultry; not always, however, but only when the fea-breeze fets in. It is then that the inhabitants of the colony breathe a frefher air, for which they have been

Senegal. been longing the whole of the day; but the air in our climate would seem a burning vapour. The nights are neverthelefs troublefome, notwithftanding the comforts of the fea-breeze. The inftant the fun is fet, we are affailed by an infinity of gnats, which are called *mufquitos;* their ftings are very painful, and their multitudes incredible. The inhabitants find but a poor defence in their gauze-curtains. For my own part, accuftomed as I had been to live among the Moors, I was but little annoyed by thefe infects. Being half a favage, I felt no defire to recommend myfelf to the favourable regard of the fair fex, and I was therefore under no neceffity of taking care of my perfon. In imitation of my former mafters, I fmeared myfelf with butter, and this expedient preferved me at all times from thefe impertinent ftingers, thefe fpiteful enemies to the repofe of the human kind.

" If the profpect of Senegal is not agreeable to the eye, much lefs are its environs, which are covered over only with fand, and overrun with mangoes. It may be faid, without exaggeration, that there is not a more forlorn fituation to be found on the face of the inhabited globe, or a place in which the common neceffaries of life are procured with greater difficulties. Water, that indifpenfable aliment of man, is here not potable. Wells are dug in the fand to the depth of five or fix feet, and water is obtained by thefe means; but whatever pains are taken to frefhen it, it ever retains a brackifh tafte. I have diftilled this water myfelf, and obferved that it always had a difagreeable favour, which cannot fail to be hurtful to the health: it is true, that when the river is high, its ftreams are frefh, but the water is only the more dangerous. It proves the caufe of moft of thofe maladies which carry off the Europeans fo rapidly, that at the end of every three years the colony has a frefh fet of inhabitants. The blacks themfelves, although accuftomed to the climate, are not in this feafon free from difeafe."

The fort of St Louis is a quadrangle, and has two baftions of confiderable ftrength; but the greateft fecurity of the fort is its natural fituation. The cannon of the fort are numerous, and the arfenal well fupplied with fmall arms and ftores. Befides this fort the French had no other upon the river, except Fort St Jofeph, which ftands about four leagues below the cataract at Govina, though they had a few factories in different parts.

The principal commodity of this country is that of gum Senegal (fee *Gum-Senegal*), which is a valuable branch of commerce, as it is ufed in many arts and manufactures, particularly by the painters in water-colours, the filk weavers, and dyers.

The French import from the river Senegal not only gum-arabic, but elephants teeth, hides, bees-wax, gold-duft, cotton, oftrich feathers, ambergris, indigo, and civet.

Notwithftanding the barrennefs of the fpot, Senegal contains more than 6000 negroes, including the captives of the Tapades, or negroes born of the black inhabitants of the country. They are never put up to fale unlefs convicted of fome crime. Their huts, conftructed in the form of bee-hives, and fupported upon four ftakes, furnifh the habitations of the negro inhabitants. The entire height of thefe huts may rife to about 12 feet, the width in every direction is commonly from 10 to 12. The beds are compofed of hurdles laid upon crofs-bars, fupported by forked ftakes at the height of about a foot from the ground. Here the flaves fleep promifcuoufly, men, women, girls, and boys. A fire is made in the middle of the hut, which is filled with fmoke, fufficient to ftifle any man but a negro. Senegal.

The men are tall, and the women are accounted the handfomeft negreffes of all Africa. The Senegalians may be confidered as the moft courageous people of that part of the world, without even excepting the Moors. Their courage, however, is more nearly allied to temerity than to bravery. In the courfe of the voyage to Galam, they meet the greateft dangers with gaiety and fong; they dread neither mufket nor cannon, and are equally fearlefs of the cayman or crocodile. Should one of their companions be killed, and devoured by thefe animals before their face, they are not deterred from plunging into the water, if the working of the fhip require it. Thefe excellent qualifications which diftinguifh them, and on which they value themfelves fo much, do not, however, preferve them from the common contagion of the country, which inclines them all to rapine. They are emulous to furpafs one another in all the arts of over-reaching and fraud. The conduct of the Europeans has, no doubt, encouraged thefe vices as much as the leffons of the marabous, who inculcate the duty of plundering the Chriftians to the utmoft of their power.

The Yolof negroes of Senegal are either Chriftians or Mahometans, or rather one and the other, or with more truth neither; religion being a matter of indifference to them. Thofe on the continent are of the fame way of thinking, and their religious practices are kept up only for the fake of form. A bar of iron, a few beads, will make them change their opinion at will. By fuch means are they acted upon; a fufficient proof of their want of all religious principle. The marabous, or priefts, and the men of their law, are no better than the reft. " I have examined the character of feveral of this order of men (fays M. Saugnier), and even among the nation of the Poules, who are confidered as great fanatics, I difcovered that they were only publicly attached to their opinions. ' This white man (fay they) does fo; he is better informed than I, and why fhould not I imitate his example?'" This way of reafoning is common to all that tract of country.

The colony of Senegal is furrounded with iflands, which, on account of the proximity of the fea, are all more unhealthy than that on which the town is built. They are full of ftanding pools, that, when dried up by the fun, exhale a putrid vapour that carries mortality with it, and defolates thefe iflands. It is doubtlefs the fame caufe that takes off fo many of the French at Senegal during the dangerous feafon of the year. This alfo may be in part occafioned by the bad quality of the water, which flows from the ponds in the neighbourhood of the colony, and though incorporated with that of the river, comes down little agitated by the current, and is eafily diftinguifhed by a vapidnefs of tafte. This particular is, in my opinion, effentially worthy of notice, and if properly attended to by our medical men, might become the means of preferving many lives.

SENEGAL-River, fee NIGER. As fo little is known refpecting this river, which is one of the greateft in Africa, any additional information muft be interefting.

 We

Senegal.

We shall therefore present our readers with the account contained in the communications presented to the Association for promoting the discovery of the Interior Parts of Africa, which, as far as we know, is the latest and most authentic.

The river known to Europeans by the name of *Niger* or *Senegal* runs on the south of the kingdom of Cashna, in its course towards Tombuctou; and if the report which Ben Alli heard in that town may be credited, it is afterwards lost in the sands on the south of the country of Tombuctou. In the map (A), only the known part of its course is marked by a line; and the suppositious part by dots. It may be proper to observe, that the Africans have two names for this river; that is, *Neel il Abeed*, or river of the Negroes; and *Neel il Kibeer*, or the great river. They also term the Nile (that is the Egyptian river) *Neel Shem;* so that the term *Neel*, from whence our Nile, is nothing more than the appellative of river; like Ganges, or Sinde.

Of this river the rise and termination are unknown, but the course is from east to west. So great is its rapidity, that no vessel can ascend its stream; and such is the want of skill, or such the absence of commercial inducements among the nations who inhabit its borders, that even with the current, neither vessels nor boats are seen to navigate. In one place, indeed, the traveller finds accommodations for the passage of himself and of his goods; but even there, though the ferrymen, by the indulgence of the sultan of Cashna, are exempted from all taxes, the boat which conveys the merchandise is nothing more than an ill-constructed raft; for the planks are fastened to the timbers with ropes, and the seams are closed both within and without by a plaster of tough clay, of which a large provision is always carried on the raft, for the purpose of excluding the stream wherever its entrance is observed.

The depth of the river at the place of passage, which is more than a hundred miles to the south of the city of Cashna, the capital of the empire of that name, is estimated at 23 or 24 feet English. Its depth is from 10 to 12 peeks, each of which is 27 inches.

Its width is such, that even at the island of Gongoo, where the ferrymen reside, the sound of the loudest voice from the northern shore is scarcely heard; and at Tombuctou, where the name of *Gnewa*, or black, is given to the stream, the width is described as being that of the Thames at Westminster. In the rainy season it swells above its banks, and not only floods the adjacent lands, but often sweeps before it the cattle and cottages of the short-sighted or too confident inhabitants.

That the people who live in the neighbourhood of the Niger should refuse to profit by its navigation, may justly surprise the traveller: but much greater is his astonishment, when he finds that even the food which the bounty of the stream would give, is uselessly offered to their acceptance; for such is the want of skill, or such the settled dislike of the people to this sort of provision, that the fish with which the river abounds are left in undisturbed possession of its waters.

Seneka || Senn.

SENEKA, or SENEGA, *Rattlesnake-root*, *Milk-wort*. See POLYGALA, BOTANY and MATERIA MEDICA Index.

SENESCHAL, (*Seneschallus*), derived from the German *sein*, "a house or place," and *scale*, "an officer." is a steward, and signifies one who has the dispensing of justice in some particular causes: As the high seneschal or steward of England: *Seneschal de la hotel de roy*, "steward of the king's household, seneschal, or steward of courts, &c." *Co. Lit.* 61. *Croke's Jurisd.* 102. *Kitch.* 83. See STEWARD.

SENN, a sort of itinerant cow-keeper in Switzerland, particularly in the canton of Appenzell. These men do not raise as much hay as is requisite for their cattle during the winter, and some of them have no grass lands. To supply this defect, they employ agents throughout the canton, whose province it is to inform them where good hay may be obtained, when the senn, who is in want of fodder, agrees with the more opulent farmers for the winter, to whom he successively drives his cattle when they return from the grass, in consequence of which he often visits five different places during the winter. The person who sells the hay provides the senn with stabling for his beasts, and with board and lodgings for himself and family. The senn pays the stipulated price for the hay, and allows his host as much milk, whey, and a kind of lean cheese, as may be made use of in the family, and also leaves him the manure of his cows. In the middle of April, the senn again issues forth with his herd to the fertile Alps, which he rents during the summer.

Fine cattle are the pride of the cow-keeper who inhabits the Alps. He adorns his best cows with large bells suspended from broad thongs, which are manufactured and sold by the inhabitants of the Tyrol. These are fastened round the cow's neck by means of a large buckle. The largest of these bells measure a foot in diameter, swelling out in the middle, and tapering towards the end. The whole peal of bells, including the thongs, is worth 150 guilders, while the apparel of the senn himself, even in his best attire, is not worth more than 20 guilders. These bells are chiefly worn in the spring, when driven to the Alps, and in the autumn or winter. It is surprising to see how proud and pleased the cows stalk forth when ornamented with their bells. One would scarcely imagine how sensible these animals are of their rank, and even touched with vanity and jealousy! Should the leading cow be deprived of her honours, she is grieved at the disgrace, which is manifested by her constant lowing, abstaining from food, and growing lean. The rival, on whom the badge of distinction has devolved, feels her marked vengeance, being wounded and persecuted by her in the most furious manner, until the former either recovers her bell, or is removed from the herd. However singular this may appear, it is rendered indisputable by the concurring testimony of centuries.

The voice of the senn brings the cows together, when dispersed on the Alps, who is then said to allure them. That the cattle can well distinguish the note of their keeper,

(A) The map alluded to is that which accompanies the volume which contains the proceedings of the Associations. This work was printed in 1791.

Senna, Sennaar.

keeper, appears from their haftening to him, though at a great diftance. He furnifhes that cow which is in the habit of ftraying fartheft with a fmall bell, and by her arrival he knows that all the reft are affembled.

SENNA, the leaf of the caffia fenna of Linnæus. See CASSIA, BOTANY and MATERIA MEDICA *Index*.

Senna appears to have been cultivated in England in the time of Parkinfon (1640); and Miller tells us, that by keeping thefe plants in a hotbed all the fummer, he frequently had them in flower; but adds, it is very rarely that they perfect their feeds in England. There can be little doubt, however, but that fome of the Britifh poffeffions may be found well enough adapted to the growth of this vegetable, and that the patriotic views of the Society for encouraging Arts, &c. which has offered a reward to thofe who fucceed in the attempt, will be ultimately accomplifhed.

Woodville's Medical Botany.

Senna, which is in common ufe as a purgative, was firft known to the Arabian phyficians Serapion and Mefue: the firft among the Greeks who takes any notice of it is Actuarius, but he only fpeaks of the fruit, and not of the leaves. To remove the difagreeable tafte of this medicine, Dr Cullen recommends coriander feeds; and, for preventing the gripings with which it is fometimes attended, he thinks the warmer aromatics, as cardamoms or ginger, would be more effectual.

The *Senna Italica*, or blunt-leaved fenna, is a variety of the Alexandrian fpecies; which, by its cultivation in the fouth of France (Provence), has been found to affume this change. It is lefs purgative than the pointed-leaved fenna, and is therefore to be given in larger dofes. It was employed as a cathartic by Dr Wright at Jamaica, where it grows on the fand banks near the fea.

Lond. Med. Jour. vol. viii.

SENNAAR, a country of Africa, bordering upon Abyffinia, with the title of a kingdom; the prefent government of which was eftablifhed in the 16th century by a race of negroes named, in their own language, *Shillook*. This country, together with all the northern parts of Africa, had been overrun by the Saracens during the rapid conquefts of the caliphs; but inftead of erecting any diftinct principalities here, as in other parts, they had incorporated themfelves with the old inhabitants called *Shepherds*, whom they found at their arrival; had converted them to their religion, and become one people with them. In 1504 the Shillook, a people before unknown, came from the weftern banks of the river Bahiar el Abiad, which empties itfelf into the Nile, and conquered the country; allowing the Arabs, however, to retain their poffeffions on condition of paying them a certain tribute. Thefe founded the city of Sennaar, and have ever fince continued to carry on an intercourfe with Egypt in the way of merchandife. At the eftablifhment of their monarchy the whole nation were Pagans, but foon after became converts to Mohammedanifm, and took the name of *Funge*, an appellation fignifying "lords or conquerors," and likewife free citizens. Mr Bruce, who paffed through this country in his return from Abyffinia, gives a lift of 20 kings who have reigned in it fince the conqueft of the Shillook.

This country is inhabited by a people fo barbarous and brutifh, that no hiftory of them can be expected. One of the moft remarkable of their cuftoms is, that the king afcends the throne with the expectation of being murdered whenever the general council of the nation thinks proper. The dreadful office of executioner belongs to one fingle officer, ftyled, in the language of the country, *Sid el Coom*; and who is always a relation of the monarch himfelf. It was from his regifters that Mr Bruce took the lift of the kings already mentioned, with the number of years they reigned, and which may therefore be received as authentic. The Sid el Coom in office at the time that Mr Bruce vifited this country was named Achmet, and was one of his beft friends. He had murdered the late king, with three of his fons, one of whom was an infant at its mother's breaft; he was alfo in daily expectation of performing the fame office to the reigning fovereign. He was by no means referved concerning the nature of his office, but anfwered freely every queftion that was put to him. When afked by Mr Bruce why he murdered the king's young fon in his father's prefence? he anfwered, that he did it from a principle of duty to the king himfelf, who had a right to fee his fon killed in a lawful and regular manner, which was by cutting his throat with a fword, and not in a more painful or ignominious way, which the malice of his enemies might poffibly have inflicted.

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Bruce's Travels, vol. iv.

The king, he faid, was very little concerned at the fight of his fon's death, but he was fo very unwilling to die himfelf, that he often preffed the executioner to let him efcape; but finding his intreaties ineffectual, he fubmitted at laft without refiftance. On being afked whether he was not afraid of coming into the prefence of the king, confidering the office he might poffibly have to perform? he replied, that he was not in the leaft afraid on this account; that it was his duty to be with the king every morning, and very late in the evening; that the king knew he would have no hand in promoting his death; but that, when the matter was abfolutely determined, the reft was only an affair of decency; and it would undoubtedly be his own choice, rather to fall by the hand of his own relation in private than by a hired affaffin, an Arab, or a Chriftian flave, in the fight of the populace. Baady the king's father, having the misfortune to be taken prifoner, was fent to Atbara to Welled Haffan the governor of that province to be put to death there. But the king, who was a ftrong man, and always armed, kept fo much upon his guard, that Welled could find no opportunity of killing him but by running him through the back with a lance as he was wafhing his hands. For this Welled himfelf was afterwards put to death; not on account of the murder itfelf, but becaufe, in the firft place, he, who was not the proper executioner, had prefumed to put the king to death; and, in the next, becaufe he had done it with a lance, whereas the only lawful inftrument was a fword.

On the death of any of the fovereigns of this country, his eldeft fon fucceeds to the throne of courfe; on which as many of his brothers as can be found are apprehended, and put to death by the Sid el Coom in the manner already related. Women are excluded from the fovereignty here as well as in Abyffinia. The princeffes of Sennaar, however, are worfe off than thofe of Abyffinia, having no fettled income, nor being treated in any degree better than the daughters of private perfons. The king is obliged, once in his lifetime, to plough and fow a piece of ground; whence he is named *Baady*, the "countryman or peafant;" a title

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title as common among the monarchs of Sennaar as Cæſar was among the Romans. The royal family were originally negroes; but as the kings frequently marry Arab women, the white colour of the mother is communicated to the child. This, we are told by Mr Bruce, is invariably the caſe, when a negro man of Sennaar marries an Arab woman; and it holds equally good, when an Arab man marries a negro woman; and he likewiſe informs us, that he never ſaw one black Arab all the time he was at Sennaar.

The ſoil and climate of this country is extremely unfavourable both to man and beaſt. The men are ſtrong and remarkable for their ſize, but ſhort lived; and there is ſuch a mortality among the children, that were it not for a conſtant importation of ſlaves, the metropolis would be depopulated. The ſhortneſs of their lives, however, may perhaps be accounted for, from their indulging themſelves from their infancy in every kind of exceſs. No horſe, mule, or aſs, will live at Sennaar or for many miles round it. The caſe is the ſame with bullocks, ſheep, dogs, cats, and poultry; all of them muſt go to the ſands every half-year. It is difficult to account for this mortality; though Mr Bruce aſſures us it is the caſe everywhere about the metropolis of this country, where the ſoil is a fat earth, during the firſt ſeaſon of the rains. Two greyhounds which he brought along with him from Atbara, and the mules he brought from Abyſſinia, lived only a few weeks after their arrival at Sennaar. Several of the kings of Sennaar have tried to keep lions, but it was always found impoſſible to preſerve them alive after the rains. They will live, however, as well as other quadrupeds, in the ſands, at no great diſtance from the capital. No ſpecies of tree except the lemon flowers near this city; the cultivation of the roſe has often been attempted, but always without ſucceſs. In other reſpects, however, the ſoil of Sennaar is exceedingly fertile, being ſaid to yield 300 fold; but this is thought by Mr Bruce to be a great exaggeration. It is all ſown with dora or millet, which is the principal food of the people; wheat and rice are alſo produced here, which are ſold by the pound, even in years of plenty. The ſoil all round is ſtrongly impregnated with ſalt, ſo that a ſufficient quantity to ſerve the inhabitants is extracted from it.

SENNAAR, a city of Africa, the capital of the kingdom of that name. It ſtands according to Mr Bruce's obſervations, in N. Lat. 13° 34′ 36″, E. Long. 33° 30′ 30″, on the weſt ſide of the Nile, and cloſe upon the banks of it; the ground on which it ſtands being juſt high enough to prevent the inundation. The town is very populous, and contains a great many houſes. In Poncet's time they were all of one ſtory; but now moſt of the officers have houſes of two ſtories high. They are built of clay mixed with a very little ſtraw, and have all flat roofs; which ſhows that the rains here muſt be much leſs in quantity than to the ſouthward. During the time of Mr Bruce's reſidence here, however, there was one week of continual rain, and the Nile, after loud thunder and great darkneſs to the ſouth, increaſed violently; the whole ſtream being covered with the wrecks of houſes and their furniture; ſo that he ſuppoſed it had deſtroyed many villages to the ſouthward. About 12 miles to the north-weſt of Sennaar is a collection of villages named *Shaddly*, from a great ſaint of that name, who conſtructed ſeveral granaries here. Theſe are no other than large pits dug in the ground, and well plaſtered in the inſide with clay, then filled with grain when it is at its loweſt price, and afterwards covered up and plaſtered again at top: theſe pits they call *matamores*. On any proſpect of dearth they are opened, and the corn ſold to the people. About 24 miles north of Shaddly there is another ſet of granaries name *Wed-Aboud*, ſtill greater than Shaddly; and upon theſe two the ſubſiſtence of the Arabs principally depends: for as theſe people are at continual war with each other, and direct their fury rather againſt the crops than the perſons of their enemies, the whole of them would be unavoidably ſtarved, were it not for this extraordinary reſource. Small villages of ſoldiers are ſcattered up and down this country to guard the grain after it is ſown, which is only that ſpecies of millet named *dora*; the ſoil, it is ſaid, being incapable of producing any other. There are great hollows made in the earth at proper diſtances throughout the country, which fill with water in the rainy ſeaſon, and are afterwards of great uſe to the Arabs as they paſs from the cultivated parts to the ſands. The fly, which is ſuch a dreadful enemy to the cattle, is never ſeen to the northward of Shaddly.

To the weſtward of theſe granaries the country is quite full of trees as far as the river Aoiad, or El-aice. In this extenſive plain there ariſe two ridges of mountains, one called *Jibbel Moira*, or the *Mountain of water*; the other *Jibbel Segud*, or the *Cold Mountain*. Both of them enjoy a fine climate, and ſerve for a protection to the farms about Shaddly and Aboud already mentioned. Here alſo are fortreſſes placed in the way of the Arabs, which ſerve to oblige them to pay tribute in their flight from the cultivated country, during the rains, to the dry lands of Atbara. Each of theſe diſtricts is governed by a deſcendant of their ancient and native princes, who long reſiſted all the power of the Arabs. Sacrifices of a horrid nature are ſaid to have been offered up on theſe mountains till about the year 1554, when one of the kings of Sennaar beſieged firſt one and then the other of the princes in their mountains; and having forced them to ſurrender, he faſtened a chain of gold to each of their ears, expoſed them in the market place at Sennaar, and ſold them for ſlaves at leſs than a farthing each. Soon after this they were circumciſed, converted to the Mahometan religion, and reſtored to their kingdoms.

"Nothing (ſays Mr Bruce) is more pleaſant than the country around Sennaar in the end of Auguſt and beginning of September. The grain, being now ſprung up, makes the whole of this immenſe plain appear a level green land, interſperſed with great lakes of water, and ornamented at certain intervals with groups of villages; the conical tops of the houſes preſenting at a diſtance the appearance of ſmall encampments. Through this very extenſive plain winds the Nile, a delightful river there, above a mile broad, full to the very brim, but never overflowing. Everywhere on theſe banks are ſeen herds of the moſt beautiful cattle of various kinds. The banks of the Nile about Sennaar reſemble the pleaſanteſt part of Holland in the ſummer ſeaſon; but ſoon after, when the rains ceaſe, and the ſun exerts its utmoſt influence, the dora begins to ripen, the leaves to turn yellow and to rot, the lakes to putrefy, ſmell, become full of vermin, and all its beauty ſuddenly diſappears: bare ſcorched Nubia returns, and all its terrors of poi-

Sennaar. Vol. iv. p. 475.

moving sands, glowing and ventilated with poisonous winds, which are followed by a troop of terrible attendants; epilepsies, apoplexies, violent fevers, obstinate agues, and lingering painful dysenteries, still more obstinate and mortal.

"War and treason seem to be the only employment of this horrid people, whom Heaven has separated by almost impassable deserts from the rest of mankind; confining them to an accursed spot, seemingly to give them an earnest in time of the only other curse which he has reserved to them for an eternal hereafter."

With regard to the climate of the country round Sennaar, Mr Bruce has several very curious observations. The thermometer rises in the shade to 119 degrees; but the degree indicated by this instrument does not at all correspond with the sensations occasioned by it, nor with the colour of the people who live under it. "Nations of blacks (says he) live within latitude 13 and 14 degrees; about 10 degrees south of them, nearly under the line, all the people are white, as we had an opportunity of observing daily in the Galla. Sennaar, which is in latitude 13 degrees, is hotter by the thermometer 50 degrees, when the sun is most distant from it, than Gondar, which is a degree farther south, when the sun is vertical.—Cold and hot (says our author) are terms merely relative, not determined by the latitude, but elevation of the place. When, therefore, we say *hot*, some other explanation is necessary concerning the place where we are, in order to give an adequate idea of the sensations of that heat upon the body, and the effects of it upon the lungs. The degree of the thermometer conveys this but very imperfectly; 90 degrees is excessively hot at Loheia in Arabia Felix; and yet the latitude of Loheia is but 15 degrees; whereas 90 degrees at Sennaar is only warm as to sense; though Sennaar, as we have already said, is in latitude 13 degrees.

"At Sennaar, then, I call it *cold*, when one fully clothed and at rest feels himself in want of fire. I call it *cool*, when one fully clothed and at rest feels he could bear more covering all over, or in part, than he has at that time. I call it *temperate*, when a man so clothed, and at rest, feels no such want, and can take moderate exercise, such as walking about a room without sweating. I call it *warm*, when a man, so clothed, does not sweat when at rest; but, on taking moderate exercise, sweats, and again cools. I call it *hot*, when a man at rest, or with moderate exercise, sweats excessively. I call it *very hot*, when a man with thin, or little clothing, sweats much, though at rest. I call it *excessive hot*, when a man, in his shirt and at rest, sweats excessively, when all motion is painful, and the knees feel feeble, as if after a fever. I call it *extreme hot*, when the strength fails, a disposition to faint comes on, a straitness is found in the temples, as if a small cord was drawn tight about the head, the voice impaired, the skin dry, and the head seems more than ordinarily large and light. This, I apprehend, denotes death at hand; but this is rarely if ever effected by the sun alone, without the addition of that poisonous wind which pursued us through Atbara, where it has, no doubt, contributed to the total extinction of every thing that hath the breath of life. A thermometer, graduated upon this scale, would exhibit a figure very different from the common one; for I am convinced by experiment, that a web of the finest muslin, wrapt round the body at Sennaar, will occasion at mid-day a greater sensation of heat in the body, than a rise of 5 degrees in the thermometer of Fahrenheit. Sennaar.

"At Sennaar, from 70 to 78 degrees of Fahrenheit's thermometer is cool; from 79 to 92 temperate; at 92 degrees begins warmth. Although the degree of the thermometer marks a greater heat than is felt by the body of us strangers, it seems to me that the sensations of the natives bear still a less proportion to that degree than ours. On the 2d of August, while I was lying perfectly enervated on a carpet in a room deluged with water at 12 o'clock, the thermometer at 116, I saw several black labourers pulling down a house, working with great vigour, without any symptoms of being incommoded."

The dress of the people of Sennaar consists only of a long shirt of blue cloth, which wraps them up from the under part of the neck to the feet. It does not, however, conceal the neck in the men, though it does in the women. The men sometimes have a sash tied about their middle; and both men and women go barefooted in the houses, whatever their rank may be. The floors of their apartments, especially those of the women, are covered with Persian carpets. Both men and women anoint themselves, at least once a-day, with camel's grease mixed with civet, which, they imagine, softens their skins, and preserves them from cutaneous eruptions; of which they are so fearful, that they confine themselves to the house if they observe the smallest pimple on their skins. With the same view of preserving their skins, though they have a clean shirt every day, they sleep with a greased one at night, having no other covering but this. Their bed is a tanned bull's hide, which this constant greasing softens very much; it is also very cool, though it gives a smell to their bodies from which they cannot be freed by any washing.

Our author gives a very curious description of the queens and ladies of the court at Sennaar. He had access to them as a physician, and was permitted to pay his visit alone. He was first shown into a large square apartment, where there were about 50 black women, all quite naked excepting a very narrow piece of cotton rag about their waists. As he was musing whether these were all queens, one of them took him by the hand, and led him into another apartment much better lighted than the former. Here he saw three women sitting upon a bench or sofa covered with blue Surat cloth; they themselves being clothed from the neck to the feet with cotton shirts of the same colour. These were three of the king's wives; his favourite, who was one of the number, appeared to be about six feet high, and so corpulent that our traveller imagined her to be the largest creature he had seen next to the elephant and rhinoceros. Her features perfectly resembled those of a negro: a ring of gold passed through her under lip, and weighed it down, till, like a flap, it covered her chin, leaving her teeth bare, which were small and very fine. The inside of her lip was made black with antimony. Her ears reached down to her shoulders, and had the appearance of wings: there was a gold ring in each of them about five inches in diameter, and somewhat smaller than a man's little finger; the weight of which had drawn down the hole where her ear was pierced

pierced so much that three fingers might easily pass above the ring. She had a gold necklace like that called *Esclavage*, of several rows, one below another; to which were hung rows of sequins pierced. She had two manacles of gold upon her ancles, larger than those used for chaining felons. Our author could not imagine how it was possible for her to walk with them, till he was informed that they were hollow. The others were dressed much in the same manner; only there was one who had chains coming from her ears to the outside of each nostril, where they were fastened. A ring was also put through the gristle of her nose, and which hung down to the opening of her mouth; having all together something of the appearance of a horse's bridle; and Mr Bruce thinks that she must have breathed with difficulty.

The poorer sort of the people of Sennaar live on the flour or bread of millet; the rich make puddings of this, toasting the flour before the fire, and putting milk and butter into it; besides which they use beef partly roasted and partly raw. They have very fine and fat horned cattle, but the meat commonly sold in the market is camel's flesh. The liver and spare rib of this animal are always eaten raw; nor did our author see one instance to the contrary all the time he was in the country. Hog's flesh is not sold in the market; but all the common people of Sennaar eat it openly; those in office, who pretend to be Mahometans, doing the same in secret.

There are no manufactures in this country, and the principal article of trade is blue Surat cloth. In former times, when caravans could pass with safety, Indian goods were brought in quantities from Jidda to Sennaar, and then dispersed over the country of the blacks. The returns were made in gold, a powder called *tibbar*, civet, rhinoceroses horns, ivory, ostrich feathers, and above all slaves or glass, more of these being exported from Sennaar than from all the east of Africa. This trade, however, as well as that of the gold and ivory, is almost destroyed; though the gold is still reputed to be the best and purest in Africa, and is therefore bought at Mocha to be carried to India, where it all centres at last.

SENNERTUS, Daniel, an eminent physician, was born in 1572 at Breslaw; and in 1593 he was sent to Wittemberg, where he made great progress in philosophy and physic. He visited the universities of Leipsic, Jena, Francfort on the Oder, and Berlin; but soon returned to Wittemberg, where he was promoted to the degree of doctor of physic, and soon after to a professorship in the same faculty. He was the first who introduced the study of chemistry into that university; he gained a great reputation by his works and practice, and was very generous to the poor. He died of the plague at Wittemberg, in 1637. He raised himself enemies by contradicting the ancients. He thought the seed of all living creatures animated, and that the soul of this seed produces organization. He was accused of impiety for asserting that the souls of beasts are not material; for this was affirmed to be the same thing with asserting that they are immortal; but he rejected this consequence, as he well might do. See Metaphysics, Part III. chap. vi.

SENONES, in *Ancient Geography*, a people of Gallia Celtica, situated on the Sequana to the south of the Parisii, near the confluence of the Jeauna or Yonne with the above mentioned river. Their most considerable exploit was their invasion of Italy, and taking and burning Rome, as related under that article. This was done by a colony of them long before transported into Italy, and settled on the Adriatic. Their capital, Agendicum in Gaul, was in the lower age called *Senones*, now *Sens*. In Italy the Senones extended themselves as far as the river Aesis; but were afterwards driven beyond the Rubicon, which became the boundary of Gallia Cisalpina, (Polybius, Strabo.)

SENSATION, in *Philosophy*, the perception of external objects by means of the senses. See Metaphysics, Part I. chap. i.

SENSE, a faculty of the soul whereby it perceives external objects by means of the impressions they make on certain organs of the body. See Metaphysics, Part I. and Anatomy, N° 137, &c.

Common Sense, is a term that has been variously used both by ancient and modern writers. With some it has been synonymous with public sense; with others it has denoted prudence; in certain instances, it has been confounded with some of the powers of taste; and, accordingly, those who commit egregious blunders with regard to decorum, saying and doing what is offensive to their company, and inconsistent with their own character, have been charged with a defect in common sense. Some men are distinguished by an uncommon acuteness in discovering the characters of others; and this talent has been sometimes called *common sense*; similar to which is that use of the term, which makes it to signify that experience and knowledge of life which is acquired by living in society. To this meaning Quintilian refers, speaking of the advantages of a public education: *Sensum ipsum qui communis dicitur, ubi discet, cum se a congressu, qui non hominibus solum, sed mutis quoque animalibus naturalis est, segregarit?* Lib. i. cap. 2.

But the term *common sense* hath in modern times been used to signify that power of the mind which perceives truth, or commands belief, not by progressive argumentation, but by an instantaneous, instinctive, and irresistible impulse; derived neither from education nor from habit, but from nature; acting independently of our will, whenever its object is presented, according to an established law, and therefore called *sense*; and acting in a similar manner upon all, or at least upon a great majority of mankind, and therefore called *common sense*. See Metaphysics, N° 127.

Moral Sense, is a determination of the mind to be pleased with the contemplation of those affections, actions, or characters, of rational agents, which we call *good* or *virtuous*.

This moral sense of beauty in actions and affections may appear strange at first view: some of our moralists themselves are offended at it in Lord Shaftesbury, as being accustomed to deduce every approbation or aversion from rational views of interest. It is certain that his Lordship has carried the influence of the moral sense very far, and some of his followers have carried it farther. The advocates for the selfish system seem to drive their opinions to the opposite extreme, and we have elsewhere endeavoured to show that the truth lies between the contending parties. See Moral Philosophy, N° 27—32.

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Public SENSE is defined by the noble author of the Characteriſtics to be an innate propenſity to be pleaſed with the happineſs of others, and to be uneaſy at their miſery. It is found, he ſays, in a greater or leſs degree in all men, and was ſometimes called κοινονοημα, or *ſenſus communis*, by ancient writers.

Of the reality of this public ſenſe we have great doubts. The conduct of ſavages, who are more under the influence of original inſtinct than civilized men, gives no countenance to it. Their affections ſeem all to be ſelfiſh, or at leaſt to ſpring from ſelf-love variouſly modified. For the happineſs of their wives they have very little regard, conſidering them merely as inſtruments of their own pleaſure, and valuing them for nothing elſe. Hence they make them toil, while they themſelves indulge in liſtleſs idleneſs. To their children we believe they exhibit ſtrong ſymptoms of attachment, as ſoon as they derive aſſiſtance from them in war, or in the buſineſs of the chace; but during the helpleſs years of infancy, the child is left by the ſelfiſh father wholly to the care and protection of its wretched mother; who, impelled by the *ſtorge* of all females to their young, cheriſhes her offspring with great fondneſs.—The ſavage is, indeed, ſuſceptible of ſtrong attachments, ſimilar to that which we call friendſhip; but ſuch attachments are no proofs of diſintereſted benevolence, or what his Lordſhip calls the *public ſenſe*. Two barbarous heroes are probably firſt linked together by the obſervation of each other's proweſs in war, or their ſkill in purſuing their game; for ſuch obſervation cannot fail to ſhow them that they may be uſeful to one another; and we have elſewhere ſhown how real friendſhip may ſpring from ſentiments originally ſelfiſh. The ſavage is very much attached to his horde or tribe, and this attachment reſembles patriotiſm: but patriotiſm itſelf is not a ſentiment of pure benevolence delighting in the happineſs of others, and grieving at their miſery; for the patriot prefers his own country to all others, and is not very ſcrupulous with reſpect to the rectitude of the means by which he promotes its intereſt, or depreſſes its rivals. The ſavage purſues with relentleſs rigour the enemies of himſelf or of the tribe to which he belongs; ſhows no mercy to them when in his power, but puts them to the cruelleſt death, and carries their ſcalps to the leader of his party. Theſe facts, which cannot be controverted, are perfectly irreconcileable with innate benevolence, or a public ſenſe comprehending the whole race of men; and ſhow the truth of that theory by which we have in another place endeavoured to account for all the paſſions, ſocial as well as ſelfiſh. See PASSION.

SENSES, PLEASURES AND PAINS OF. The natural agreeableneſs, diſagreeableneſs and indifference of our ſenſations and perceptions, preſent to the mind an important and extenſive field of inquiry; and on this ſubject we ſhall here make a few obſervations. All our ſenſes have been certainly beſtowed upon us for wiſe and beneficent purpoſes; and, accordingly, we find, that all of them, when properly cultivated, or exerciſed and improved, are capable of affording us much pleaſure. The ſenſes of ſmell and of taſte ſeem rather intended for the preſervation of our animal exiſtence, and in this point of view are properly an object of the natural hiſtory of man; whilſt the other three ſeem to be more peculiarly intended for our mental improvement, and accordingly form an object of intellectual and of moral philoſophy. And agreeably to this we know that we derive a great deal of very uſeful knowledge, in an eaſy and ſimple manner, concerning the objects that ſurround us, in the early part of life, from all the ſenſes, particularly from ſight and touch, and this too without labour or ſtudy. But this is not the only purpoſe for which the ſenſes were deſigned.

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It being thus certain, that the ſenſes were beſtowed upon us partly to preſerve our animal exiſtence, and partly for our mental improvement, it ſeems reaſonable, even *à priori*, to expect that nature would attach ſome pleaſure to ſuch uſe and exerciſe of them, as are calculated to promote theſe ends, and pain to the contrary; particularly in thoſe inſtances in which ſhe has left the management of them ſubject to our own controul. And accordingly we cannot but obſerve what delight we derive from our ſenſes, eſpecially in the morning of life, by which it would ſeem, that nature intended thus winningly to invite us to the proper exerciſe and improvement of them; and as it were unconſciouſly, acquire much uſeful knowledge. It is this ſpecies of pleaſure that ſupports and excites boys in the conſtant and often immoderate exerciſe of their organs of voluntary motion; the powers of which are thus increaſed and invigorated.

The exerciſe and improvement of the ſenſes being ſubſervient to our intellectual improvement, nature has alſo kindly attached much refined and rational pleaſure to the mental exertions; ſo that we are thus ſeduced, as it were, to the cultivation of the various extraordinary powers and faculties of the mind.

It is evident that nature has given ſuch organs and faculties to man, as are calculated not only to make him live, but alſo to render life agreeable. Here too we obtain a ſlight glimpſe at leaſt of ſome of the final cauſes of the pleaſures of ſenſe. But if it be aſked how it happens, that there are ſuch wide diverſities between our ſenſations, ſome being by nature very agreeable to all men, and ſome as diſagreeable, whilſt there are others ſo indifferent, as to give neither pleaſure nor pain, we muſt confeſs, that we can give no ſatisfactory anſwer, to ſhew how ſo many very different ſenſations are produced by various kinds of impreſſions made on certain organs of the body, and how all theſe different impreſſions excite ſuch ſenſations as ſuggeſt not only correſponding perceptions and external qualities, but at the ſame time affect the mind with pleaſure, pain, trouble, anxiety, or diſguſt. To be ſucceſsful in theſe inquiries, we muſt preſuppoſe ſome knowledge of the nature of the connection ſubſiſting between the mind and body, which there is reaſon to think is placed beyond the limits preſcribed by nature to human reſearch.

The pleaſure or pain which conſtantly attends certain ſenſations is not uniform in degree, but varies conſiderably, not only in different individuals, but even in the ſame perſons at different times. It is not thus with the ſenſations themſelves. Theſe are always conſtant and uniform. The ſame kind of impreſſion, when the organs &c. are ſound, uniformly and invariably produce ſimilar ſenſations; and theſe are as invariably followed by the perception of their own peculiar exciting cauſes. For any particular impreſſion is never known to excite in the ſame perſon a new ſenſation, or the perception of an external object different from that which it previouſly ſuggeſted,

ſuggeſted, excepting in caſes of diſeaſe. And when it does rarely occur, as in thoſe who cannot diſtinguiſh a particular colour, ſmell or taſte, from certain others, we uniformly attribute it to diſeaſe or malconformation. Were we not thus to have uniformly ſimilar ſenſations and perceptions of external objects from ſimilar impreſſions, the ſenſes would not be at all ſubſervient to our intellectual improvement; ſince, by giving different leſſons concerning the ſame or ſimilar objects at different times, they would render it impoſſible for us to be certain of any thing, or to benefit by experience.

The effects of cuſtom, which are at all times ſo conſiderable and evident with reſpect both to the mind and body, (as in the caſe of particular organs or faculties much improved by attention and exerciſe,) have little or no influence at all in interrupting or modifying this uniformity in our ſenſations and perceptions. For no ſound, or properly organized perſon will, either naturally or by cuſtom, ever miſtake hardneſs for ſoftneſs, red for green, or ſweet for bitter. But the influence of cuſtom in modifying the pains and pleaſures of ſenſe is well known and conſiderable. For a perſon, who can moſt accurately diſtinguiſh ſweetneſs from ſourneſs, will at the ſame time, either by particular conformation, or more frequently in conſequence of uſe and habit, prefer wormwood or tobacco to honey.

But although we may deſpair of being ever able to diſcover the phyſical cauſe of the pleaſures and pains of the ſenſes, we may, however, advance a little by obſerving and regiſtering particular facts. It is, accordingly, of uſe to remark, that every ſpecies of ſenſation, if its nature be otherwiſe unchanged, is agreeable or diſagreeable in proportion to its ſtrength or intenſeneſs. For there is no ſenſation, however agreeable, that will not become diſagreeable, and even intolerable, if it be immoderately intenſe. Whilſt on the contrary, thoſe, which by their ſtrength and nature are very troubleſome, if rendered more mild and moderate become not only tolerable, but agreeable. Thus, with reſpect to the ſenſes it would ſeem, that pain and pleaſure are only different degrees of the ſame feeling, and when we conſider the great varieties of which the ſenſation, not only of different organs, but even of any one of them, is ſuſceptible, and that each degree of theſe may be accompanied with pleaſure or pain, more or leſs, we muſt conclude that the pains and pleaſures of ſenſe are capable of numberleſs modifications both in degree and in kind.

We frequently obſerve, that ſenſations which were at firſt agreeable, if often repeated, loſe their reliſh, though the nature and ſtrength of the impreſſions be the ſame; whilſt others from being at firſt very diſagreeable, as the taſte of tobacco and opium, become very pleaſing, though the nature and ſtrength of the impreſſions have ſuffered no change. For the explanation of ſuch facts as theſe we muſt have recourſe to the effects of cuſtom. Thus, in both theſe oppoſite caſes, the ſenſations from being often repeated, loſe part of the ſtrength, and of the novelty, of courſe, of their firſt impreſſions; and, with reſpect to the former inſtance, being unable to command the attention, become in the courſe of time almoſt wholly, or altogether neglected, whilſt in the latter caſe, from being very offenſive, they become highly agreeable. But if it be aſked why habit and cuſtom produce theſe effects, and in what manner, we are unable to explain it farther, than by ſaying, ſince the fact is unqueſtionable, that ſuch is the nature of the human conſtitution. Of the effects themſelves, no man can entertain a doubt; and their cauſes, though at preſent unknown, may by time and inquiry be further developed and ſimplified. "The labyrinth," ſays Dr Reid, "may be too intricate, and the thread too fine, to be traced through all its windings; but if we ſtop where we can trace it no farther, and ſecure the ground we have gained, there is no harm done; a quicker eye may in time trace it further."

Theſe principles are capable of affording us ſtill farther explanations. Why are new ſenſations always more agreeable and variety ſo pleaſing? Becauſe they fix the attention more, and are not as yet blunted by frequent repetition or by habit. It is becauſe ſome ſenſations loſe their wonted effects by cuſtom and by repetition, that we require ſtronger ones, or at leaſt ſtronger impreſſions on the organs and nerves, to increaſe or continue our pleaſures. It is alſo in conſequence of their becoming leſs poignant through habit that we neglect ſo many pleaſures, which we hardly know to be ſuch, till they have flown for ever; and it is becauſe in the morning of life every thing has more novelty, and becauſe habit has not deſtroyed their reliſh, that the pleaſures of youth are much more intenſe than thoſe of age. The degree of pleaſure is ſimilar to that which a blind man would feel on being made to ſee, or to that which a man would enjoy on ſuddenly acquiring a new ſenſitive faculty, although by long uſe and habit theſe pleaſures are at preſent for the moſt part or wholly blotted away.

Although moſt ſenſations, when ſtrong and lively enough to make themſelves accurately and eaſily diſtinguiſhed, generally pleaſe moſt, each in its own kind and manner; ſtill, as there are different kinds of pleaſure, different ſenſations may pleaſe the mind in various ways; and accordingly, it is not from the luſtre of the midday ſun, nor from the beautiful and lively appearance of all nature at noon, ſolely that the eyes derive pleaſure, any more than grand muſical ſounds are the only things that pleaſe the ear. For we often contemplate with a very different and a very conſiderable degree of pleaſure the ſublime and awful ſcenes of nature, the twilight darkneſs of the ſhady grove, and even the gloomy horror of night itſelf. We liſten with delight to the tempeſt ſhaking the foreſt, as well as to the gentle murmurs of the paſſing ſtream. There is even a time when nothing gives ſo much pleaſure as darkneſs, ſilence, and the abſence of all ſenſation.

Amidſt the great variety of good and evil with which we are every where ſurrounded, it is a matter of the higheſt importance to be able to diſcern aright. This we ſhould be incapable of doing were we not endowed with agreeable as well as painful ſenſations. Theſe ſerve to direct our choice. Whatever contributes in any degree to our preſervation and to the improvement of our organs and faculties, is accompanied with pleaſure; and on the contrary, when we are threatened with danger a painful ſenſation gives us the alarm. It is to the eſtabliſhment of this law that we are indebted for the duration of our lives, the improved and vigorous ſtate of our faculties, and the enjoyment of that ſmall portion of happineſs allotted to us by nature. "God, (ſays a French writer) having endowed man with various faculties, bodily as well as intellectual, in order to promote his happineſs, Senſes

piness, he vouchſafes to conduct him to this noble end, not only by the deductions of reaſon, but alſo by the force of inſtinct and ſenſation, which are more powerful and efficacious principles. Thus nature, by a ſenſation of pain, inſtantaneouſly appriſes us of what might prove hurtful to us; and, on the contrary, by an agreeable ſenſation, gently leads us to whatever may tend to the preſervation of our exiſtence, and to the perfect ſtate of our faculties, theſe being the two points on which our happineſs depends. Our faculties can neither be of uſe, nor diſplay themſelves farther than as we exerciſe them; motion or action is therefore ſo neceſſary to us, that without it we muſt inevitably ſink into a deplorable ſtate of inſenſibility and languor. On the other hand, as we are weak and limited creatures, all exceſſive and violent action would impair and deſtroy our organs; we muſt therefore uſe only moderate motion or exerciſe, ſince by theſe means the uſe or perfection of our faculties is reconciled with our chief intereſt, which is ſelf-preſervation. Now it is to this happy medium, I mean to a moderate exerciſe of our faculties that the author of our nature has ſo wiſely annexed pleaſure.

The pleaſures of ſenſe are thus confined within narrow limits; for they cannot be much increaſed without pain, or often repeated without loſing their reliſh, at leaſt in a great meaſure; nor can they be long continued, partly for the ſame reaſon, and becauſe they exhauſt the mind, or rather the nervous ſyſtem. Hence we ſee that our animal appetites are confined within a narrow range, as is evident from the effects of exceſs in eating and drinking. All our ſenſitive powers are impaired; whilſt, on the contrary, our intellectual powers are ſtrengthened and improved by uſe and exerciſe. And in proportion as we indulge our ſenſitive powers, our deſires of indulgence increaſe, whilſt the pleaſures, which are the objects of theſe deſires, become regularly leſs poignant. Theſe, indeed, are wiſe regulations of nature; for it would ſeem as if ſhe intended to whiſper gently to us in this way, by means of practical experience, that we are not born ſolely for the enjoyment of pleaſure, at leaſt not for that of the pleaſures of the ſenſes: for all of them, as we have already remarked, if much indulged, lead to liſtleſsneſs and diſguſt, and ſometimes to conſiderable pain. And indeed, juſt as pleaſure paſſes thus readily into trouble and pain, ſo does the ſudden ceſſation of pain, at leaſt when this has been conſiderable, produce often extraordinary pleaſure. So that we may here apply the beautiful allegory of the divine Socrates, " that although pleaſure and pain are contrary in their nature, and have their faces turned different ways, yet that Jupiter hath tied them ſo together, that he who lays hold of the one draws the other along with it."

We have juſt ſaid, that the *ſudden* ceſſation of pain, at leaſt when this has been conſiderable, produces often extraordinary pleaſure. But this opinion ſeems to be denied in a late inquiry concerning taſte. " Among the pleaſures of ſenſe," ſays Mr Knight, " more particularly among thoſe belonging to touch, there is a certain claſs, which, though ariſing from negative cauſes, are nevertheleſs real and poſitive pleaſures: as when we gradually ſink from any violent or exceſſive degree of action or irritation into a ſtate of tranquillity and repoſe. I ſay *gradually*; for if the tranſition be ſudden and abrupt, it will not be pleaſant; the pleaſure ariſing from the inverted action of the nerves, and not from the utter ceſſation of action. From this inverted action ariſes the gratification which we receive from a cool breeze, when the body has been exceſſively heated; or from the rocking of a cradle, or the gentle motion of a boat, or eaſy carriage, after having been fatigued with violent exerciſe. Such, too, is that which twilight, or the gloomy ſhade of a thicket, affords to the eye after it has been dazzled by the blaze of the mid-day ſun; and ſuch, likewiſe, is that which the ear receives from the gradual diminution of loudneſs of tone in muſic." That pleaſure follows a gradual ceſſation of any violent action or irritation, we mean not to deny; but we are at a loſs to comprehend how it follows, that the tranſition from ſtrong pain, if it be ſudden and abrupt, will not be pleaſant.

But although the pleaſures of ſenſe be thus limited, theſe limits are very different with reſpect to the different ſenſes. Some of them are ſoon exhauſted, and do not any longer diſtinguiſh well the objects that correſpond to them; nor are they pleaſed with thoſe objects which were at firſt very agreeable, and which they diſtinguiſh with ſufficient accuracy; whilſt others continue to perform their functions longer, and enjoy a more continued pleaſure. Thus the ſenſes of ſmell and of taſte are almoſt immediately ſatiated; the ſenſe of hearing more ſlowly; but the ſight is in this reſpect the laſt of all to be fatigued or ſatiated: whilſt the pleaſures that ariſe from the exerciſe of our mental faculties are by far the moſt durable of all. " Exerciſe of the mind is as neceſſary as that of the body to preſerve our exiſtence. The ſenſes of other animals, being more quick than ours, are ſufficient to direct them to follow what is agreeable to their nature, or to ſhun whatever is contrary thereto. But we are endowed with reaſon in order to ſupply the deficiency of our ſenſes; and pleaſure preſents herſelf as an incitement to exerciſe, in order to keep the mind from a ſtate of hurtful inactivity. Pleaſure is not only the parent of ſports and amuſements, but alſo of arts and ſciences: and as the whole univerſe is, as it were, forced by our induſtry to pay tribute to our wants and deſires, we cannot but acknowledge our obligation to that law of nature, which has annexed a degree of pleaſure to whatever exerciſes without fatiguing the mind. The pleaſure accompanying it is ſometimes ſo great that it tranſports the very ſoul, ſo that ſhe ſeems as it were diſengaged from the body. We know what is recorded in hiſtory concerning Archimedes (A), and ſeveral other geometricians both ancient and modern. If we

(A) When Syracuſe was taken by the Romans under Marcellus, Archimedes was in his ſtudy, ſo intent upon ſome geometrical problems, that he neither heard the clamour of the Romans, nor perceived that the city was taken. In this tranſport of ſtudy and contemplation a ſoldier came on him with his drawn ſword; Archimedes, on ſeeing him, beſought him to hold his hand till he had finiſhed the problem he was about. But the ſoldier, deaf to his intreaty, ran him through the body, although Marcellus, upon entering the city, had given orders that Archimedes ſhould be ſpared.

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we doubt the truths of such facts, we must at least acknowlege their probability, since we meet every day with a number of similar examples. When we see a chess-player so deeply immersed in thought as to be in a manner lost to his outward senses, should we not imagine him to be wholly engrossed with the care of his own private affairs, or of the public weal? but the object of all this profound meditation is the pleasure of exercising the mind by the movement of a piece of ivory. From this exercise of the mind also arises the pleasure we sometimes take in refined and delicate sentiments, which, after the manner of Virgil's shepherdess, (*Et fugit ad salices, sed se cupit ante videri*), are sometimes artfully concealed, but so as to afford us the pleasure of discovering them *."

Theorie des Sentimens agreables.

From some of the foregoing remarks we also see that nature points out to us the superiority and excellence of our mental faculties, thus suggesting to us that we ought to cultivate them most, as being our better and our nobler part, to the cultivation of which that of our sensitive faculties should be merely subservient. But, although our pleasures are thus by nature rendered in a great degree independent of ourselves, still we have it in our power to make them all more durable, by varying and mixing them with one another, or by interposing between those that are very agreeable others that are less pleasing, so as that no individual pleasure shall be in excess.

Besides the circumstances already noticed, there are others of a very different kind, which have also considerable influence on the pleasures of the senses; such as different conditions of the whole body, particularly of the nerves, or of certain organs or functions, to which functions some organs of sense, and perhaps even the sensation of these, are in a great measure subservient. This is one of the causes why many pleasures, which we cultivate with all our might, cannot be immortal. If a person be thirsty, spring water is nectar to him; if hungry, any kind of food is agreeable, even the smell of food is grateful. To a man in a heat, or in a fever, cold is pleasing; and to one in a cold fit nothing is so agreeable as heat. To these same persons, at other times, so far are these things from being agreeable, that they are often disgusting. The most decided glutton cannot always relish a sumptuous feast.

Besides the sensations excited by external objects, there are others also which cause pain and pleasure. If the action of the muscles be strong, easy, and cheerful, and not continued so as to fatigue us, it causes pleasure. On the contrary, when this action is attended with a sense of listlessness, lassitude, difficulty, and debility, it causes pain more or less. In fine, various states and affections of the mind, such as the exercise of memory, imagination, and judgement, nearly for similar reasons, are sometimes painful, at other times agreeable. "Animi affectus, qui modici grate excitant, vehementes, aut graves et diuturni, hujus pariter ac corporis vires frangunt; hominem interdum statim extinguunt, sæpius longa valetudine macerant. Somni etiam, quo ad exhaustas vires reficiendas egemus, excessus, vel defectus, et animo et corpori nocet"—"Desidia, sive animi sive corporis, utriusque vires languescunt: nimia exercitatione haud minus læduntur. Statuit enim provida rerum parens, ut singularum partium, et universi corporis animique vires usu roborentur et acuantur; et huic itidem certos fines posuit: ita ut neque quem voluit natura usus impune omittatur, neque ultra modum intendatur *."

* Gregory's Conspectus.

"Of such sensations and feelings as are agreeable or disagreeable, we may remark," says Dr Reid, "that they differ much, not only in degree, but in kind and in dignity. Some belong to the animal part of our nature, and are common to us with the brutes: others belong to the rational and moral part. The first are more properly called *sensations*, the last *feelings*. The French word *sentiment* is common to both."

"The Author of nature, in the distribution of agreeable and painful feelings, hath wisely and benevolently consulted the good of the human species; and hath even shewn us, by the same means, what tenor of conduct we ought to hold. For, *first*, The painful sensations of the animal kind are admonitions to avoid what would hurt us; and the agreeable sensations of this kind invite us to those actions that are necessary to the preservation of the individual, or of the kind. *Secondly*, By the same means nature invites us to moderate bodily exercise, and admonishes us to avoid idleness and inactivity on the one hand, and excessive labour and fatigue upon the other. *Thirdly*, The moderate exercise of all our rational powers gives pleasure. *Fourthly*, Every species of beauty is beheld with pleasure, and every species of deformity with disgust; and we shall find all that we call beautiful, to be something estimable, or useful in itself, or a sign of something that is estimable or useful. *Fifthly*, The benevolent affections are all accompanied with an agreeable feeling, the malevolent with the contrary. And, *Sixthly*, The highest, the noblest and most durable pleasure is that of doing well and acting the part that becomes us; and the most bitter and painful sentiment is the anguish and remorse of a guilty conscience." These observations with regard to the economy of nature in the distribution of our painful and agreeable sensations and feelings are so well illustrated by the elegant and judicious author of *Theorie des Sentiments agreables*, that we deem it unnecessary to make any further remarks on this subject. (See Happiness and Pleasure.) A little reflection may satisfy us, that the number and variety of our sensations and feelings are prodigious. For, to omit all those which accompany our appetites, passions, and affections, our moral sentiments and sentiments of taste, even our external senses, furnish a great variety of sensations differing in kind, and almost in every kind an endless variety of degrees. Every variety we discern, with regard to taste, smell, sound, colour, heat, and cold, and in the tangible qualities of bodies, is indicated by a sensation corresponding to it.

The most general and the most important division of our sensations and feelings is into the agreeable, the disagreeable, and the indifferent. Every thing we call pleasure, happiness, or enjoyment, on the one hand; and, on the other, every thing we call misery, pain, or uneasiness, is sensation or feeling: For no man can for the present be more happy, or more miserable, than he feels himself to be. He cannot be deceived with regard to the enjoyment or suffering of the present moment.

But, besides the sensations that are agreeable or disagreeable, there is still a greater number that are indifferent. To these we give so little attention, that they have no name, and are immediately forgotten as if they had never been; it even requires attention to the operations of our minds to be convinced of their existence. For this end we may observe, that to a good ear every human voice is distinguishable from all others. Some voices are pleasant, some disagreeable; but the far greater part cannot be said to be one or the other. The same thing may be said of other sounds, and no less of tastes, smells, and colours; and if we consider, that our senses are in continual exercise while we are awake, that some sensation attends every object they present to us, and that familiar objects seldom raise any emotion pleasant or painful; we shall see reason, besides the agreeable and disagreeable, to admit a third class of sensations, that may be called indifferent. But these sensations that are indifferent are far from being useless. They serve as signs to distinguish things that differ; and the information we have concerning things external comes by these means. Thus, if a man had not a musical ear so as to receive pleasure from the harmony or melody of sounds, he would still find the sense of hearing of great utility. Though sounds gave him neither pleasure nor pain, of themselves, they would give him much useful information; and the same may be said of the sensations we have by all the other senses.

SENSIBLE NOTE, in *Music*, is that which constitutes a third major above the dominant, and a semitone beneath the tonic. *Si*, or B, is the sensible note in the tone of *ut* or C *sol* ※; or G sharp, in the tone of *la* or A.

They call it the *sensible note* on this account, that it causes to be perceived the tone or natural series of the key and the tonic itself; upon which, after the chord of the dominant, the sensible note taking the shortest road, is under a necessity of rising; which has made some authors treat this sensible note as a major dissonance, for want of observing, that dissonance, being a relation, cannot be constituted unless by two notes between which it subsists.

It is not meant that the sensible note is the seventh of the tone, because, in the minor mode, this seventh cannot be a sensible note but in ascending; for, in descending, it is at the distance of a full note from the tonic, and of a third minor from the dominant.

SENSIBILITY, is a nice and delicate perception of pleasure or pain, beauty or deformity. It is very nearly allied to taste; and, as far as it is natural, seems to depend upon the organization of the nervous system. It is capable, however, of cultivation, and is experienced in a much higher degree in civilized than in savage nations, and among persons liberally educated than among boors and illiterate mechanics. The man who has cultivated any of the fine arts has a much quicker and more exquisite perception of beauty and deformity in the execution of that art, than another of equal or even greater natural powers, who has but casually inspected its productions. He who has been long accustomed to that decorum of manners which characterizes the polite part of the world, perceives almost instantaneously the smallest deviation from it, and feels himself almost as much hurt by behaviour harmless in itself, as by the grossest rudeness; and the man who has long proceeded steadily in the paths of virtue, and often painted to himself the deformity of vice, and the miseries of which it is productive, is more quickly alarmed at any deviation from rectitude, than another who, though his life has been stained by no crime, has yet thought less upon the principles of virtue and consequences of vice.

Every thing which can be called sensibility, and is not born with man, may be resolved into association, and is to be regulated accordingly; for sensibilities may be acquired which are inimical to happiness and to the practice of virtue. The man is not to be envied who has so accustomed himself to the forms of polite address as to be hurt by the unaffected language and manners of the honest peasant, with whom he may have occasion to transact business; nor is he likely to acquire much useful knowledge who has so sedulously studied the beauties of composition as to be unable to read without disgust a book of science or of history, of which the style comes not up to his standard of perfection. That sensibility which we either have from nature, or necessarily acquire, of the miseries of others, is of the greatest use when properly regulated, as it powerfully impels us to relieve their distress; but if it by any means become so exquisite as to make us shun the sight of misery, it counteracts the end for which it was implanted in our nature, and only deprives us of happiness, while it contributes nothing to the good of others. Indeed there is reason to believe that all such extreme sensibilities are selfish affectations, employed as apologies for withholding from the miserable that relief which it is in our power to give; for there is not a fact better established in the science of human nature, than that passive perceptions grow gradually weaker by repetition, while active habits daily acquire strength.

It is of great importance to a literary man to cultivate his taste, because, it is the source of much elegant and refined pleasure, (see TASTE); but there is a degree of fastidiousness which renders that pleasure impossible to be obtained, and is the certain indication of expiring letters. It is necessary to submit to the artificial rules of politeness, for they tend to promote the peace and harmony of society, and are sometimes a useful substitute for moral virtue; but he who with respect to them has so much sensibility as to be disgusted with all whose manners are not equally polished with his own, is a very troublesome member of society. It is every man's duty to cultivate his moral sensibilities, so as to make them subservient to the purposes for which they were given to him; but if he either feel, or pretend to feel, the miseries of others to so exquisite a degree as to be unable to afford them the relief which they have a right to expect, his sensibilities are of no good tendency.

That the man of true sensibility has more pains and more pleasures than the callous wretch, is universally admitted, as well as that his enjoyments and sufferings are more exquisite in their kinds; and as no man lives for himself alone, no man will acknowledge his want of sensibility, or express a wish that his heart were callous. It is, however, a matter of some moment to distinguish real sensibilities from ridiculous affectations; those which tend to increase the sum of human happiness from such as have a contrary tendency; and to cultivate them all in such a manner as to make them answer the ends for which they were implanted in us by the beneficent Author of nature. This can be done only by watching over them as over other associations, (see METAPHYSICS, N° 98.); for excessive sensibility, as it is not the gift of nature, is the bane of human happiness. "Too much tenderness (as Rousseau well observes) proves the bitter-

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eſt curſe inſtead of the moſt fruitful bleſſing; vexation and diſappointment are its certain conſequences. The temperature of the air, the change of the ſeaſons, the brilliancy of the ſun, or thickneſs of the fogs, are ſo many moving ſprings to the unhappy poſſeſſor, and he becomes the wanton ſport of their arbitration."

SENSITIVE-PLANT, See MIMOSA, DIONÆA, and HEDYSARUM, BOTANY *Index*

The ſenſitive plants are well known to poſſeſs a kind of motion, by which the leaves and ſtalks are contracted and fall down on being ſlightly touched, or ſhaken with ſome degree of violence.

The contraction of the leaves and branches of the ſenſitive plant when touched, is a very ſingular phenomenon. Different hypotheſes have been formed by botaniſts in order to explain it; but we are diſpoſed to believe that theſe have generally been deduced rather from analogical reaſoning than from a collection of facts and obſervations. We ſhall therefore give an account of all the important facts which we have been able to collect upon this curious ſubject; and then draw ſuch concluſions as obviouſly reſult from them, without, however, attempting to ſupport any old, or to eſtabliſh a new, hypotheſis.

1. It is difficult to touch the leaf of a healthy ſenſitive plant ſo delicately that it will not immediately collapſe, the foliola or little leaves moving at their baſe till they come into contact, and then applying themſelves cloſe together. If the leaf be touched with a little more force, the oppoſite leaf will exhibit the ſame appearance. If a little more force be applied, the partial footſtalks bend down towards the common footſtalk from which they iſſue, making with it a more acute angle than before. If the touch be more violent ſtill, all the leaves ſituated on the ſame ſide with the one that has been touched will inſtantly collapſe, and the partial footſtalk will approach the common footſtalk to which it is attached, in the ſame manner as the partial footſtalk of the leaf approaches the ſtem or branch from which it iſſues; ſo that the whole plant, from having its branches extended, will immediately appear like a weeping birch.

2. Theſe motions of the plant are performed by means of three diſtinct and ſenſible articulations. The firſt, that of the foliola or lobes to the partial footſtalk; the ſecond, that of the partial footſtalk to the common one; the third, that of the common footſtalk to the trunk. The primary motion of all which is the cloſing of the leaf upon the partial footſtalk, which is performed in a ſimilar manner, and by a ſimilar articulation. This, however, is much leſs viſible than the others. Theſe motions are wholly independent on one another, as may be proved by experiment. It appears that if the partial footſtalks are moved, and collapſe toward the petioli, or theſe toward the trunk, the little leaves, whoſe motion is uſually primary to theſe, ſhould be affected alſo; yet experiment proves that it is poſſible to touch the footſtalks in ſuch a manner as to affect them only, and make them apply themſelves to the trunk, while the leaves feel nothing of the touch; but this cannot be, unleſs the footſtalks are ſo diſpoſed as that they can fall to the trunk, without ſuffering their leaves to touch any part of the plant in their paſſage, becauſe, if they do, they are immediately affected.

3. Winds and heavy rains make the leaves of the ſenſitive plant contract and cloſe; but no ſuch effect is produced from ſlight ſhowers.

4. At night, or when expoſed to much cold in the day, the leaves meet and cloſe in the ſame manner as when touched, folding their upper ſurfaces together, and in part over each other, like ſcales or tiles, ſo as to expoſe as little as poſſible of the upper ſurface to the air. The oppoſite ſides of the leaves (foliola) do not come cloſe together in the night, for when touched they apply themſelves cloſer together. Dr Darwin kept a ſenſitive plant in a dark place for ſome hours after daybreak; the leaves and footſtalks were collapſed as in its moſt profound ſleep; and, on expoſing it to the light, above 20 minutes paſſed before it was expanded.

5. In the month of Auguſt, a ſenſitive plant was carried in a pot out of its uſual place into a dark cave, the motion that it received in the carriage ſhut up its leaves, and they did not open till 24 hours afterwards; at this time they became moderately open, but were afterwards ſubject to no changes at night or morning, but remained three days and nights with their leaves in the ſame moderately open ſtate. At the end of this time they were brought out again into the air, and there recovered their natural periodical motions, ſhutting every night, and opening every morning, as naturally and as ſtrongly as if the plant had not been in this forced ſtate; and while in the cave, it was obſerved to be very little leſs affected with the touch than when abroad in the open air.

6. The great heats of ſummer, when there is open ſunſhine at noon, affect the plant in ſome degree like cold, cauſing it to ſhut up its leaves a little, but never in any very great degree. The plant, however, is leaſt of all affected about nine o'clock in the morning, and that is conſequently the propereſt time to make experiments on it. A branch of the ſenſitive plant cut off, and laid by, retains yet its property of ſhutting up and opening in the morning for ſome days; and it holds it longer if kept with one end in water, than if left to dry more ſuddenly.

7. The leaves only of the ſenſitive plant ſhut up in the night, not the branches; and if it be touched at this time, the branches are affected in the ſame manner as in the day, ſhutting up, or approaching to the ſtalk or trunk, in the ſame manner, and often with more force. It is of no conſequence what the ſubſtance is with which the plant is touched, it anſwers alike to all; but there may be obſerved a little ſpot, diſtinguiſhable by its paler colour in the articulations of its leaves, where the greateſt and niceſt ſenſibility is evidently placed.

8. Duhamel having obſerved, about the 15th of September, in moderate weather, the natural motion of a branch of a ſenſitive plant, remarked, that at nine in the morning it formed with the ſtem an angle of 100 degrees; at noon, 112 degrees; at three afternoon, it returned to 100; and after touching the branch, the angle was reduced to 90. Three quarters of an hour after it had mounted to 112; and, at eight at night, it deſcended again, without being touched, to 90. The day after, in finer weather, the ſame branch, at eight in the morning, made an angle of 135 degrees with the ſtem; after being touched, the angle was diminiſhed to 80; an hour after, it roſe again to 135; being touched a ſecond time, it deſcended again to 80; an hour and a half after, it had riſen to 145; and on being touched

Senſitive. touched a third time, deſcended to 135; and remained in that poſition till five o'clock in the afternoon, when being touched a fourth time it fell to 110.

9. The parts of the plants which have collapſed afterwards unfold themſelves, and return to their former expanded ſtate. The time required for that purpoſe varies, according to the vigour of the plant, the ſeaſon of the year, the hour of the day, the ſtate of the atmoſphere. Sometimes half an hour is requiſite, ſometimes only ten minutes. The order in which the parts recover themſelves varies in like manner: ſometimes it is the common footſtalk; ſometimes the rib to which the leaves are attached; and ſometimes the leaves themſelves are expanded, before the other parts have made any attempt to be reinſtated in their former poſition.

10. If, without ſhaking the other ſmaller leaves, we cut off the half of a leaf or lobe belonging to the laſt pair, at the extremity or ſummit of a wing, the leaf cut, and its antagoniſt, that is to ſay, the firſt pair, begin to approach each other; then the ſecond, and ſo on ſucceſſively, till all the leſſer leaves, or lobes of that wing, have collapſed in like manner. Frequently, after 12 or 15 ſeconds, the lobes of the other wings, which were not immediately affected by the ſtroke, ſhut; whilſt the ſtalk and its wing, beginning at the bottom, and proceeding in order to the top, gradually recover themſelves. If, inſtead of one of the leſſer extreme leaves, we cut off one belonging to the pair that is next the footſtalk, its antagoniſt ſhuts, as do the other pairs ſucceſſively, from the bottom to the top. If all the leaves of one ſide of a wing be cut off, the oppoſite leaves are not affected, but remain expanded. With ſome addreſs, it is poſſible even to cut off a branch without hurting the leaves, or making them fall. The common footſtalk of the winged leaves being cut as far as three-fourths of its diameter, all the parts which hang down collapſe, but quickly recover without appearing to have ſuffered any conſiderable violence by the ſhock. An inciſion being made into one of the principal branches to the depth of one half the diameter, the branches ſituated betwixt the ſection and the root will fall down; thoſe above the inciſion remain as before, and the leſſer leaves continue open; but this direction is ſoon deſtroyed, by cutting off one of the lobes at the extremity, as was obſerved above. Laſtly, a whole wing being cut off with precaution near its inſertion into the common footſtalk, the other wings are not affected by it, and its own lobes do not ſhut. No motion enſues from piercing the branch with a needle or other ſharp inſtrument.

11. If the end of one of the leaves be burned with the flame of a candle, or by a burning glaſs, or by touching it with hot iron, it cloſes up in a moment, and the oppoſite leaf does the ſame, and after that the whole ſeries of leaves on each ſide of the partial or little footſtalk; then the footſtalk itſelf; then the branch or common footſtalk; all do the ſame, if the burning has been in a ſufficient degree. This proves that there is a very nice communication between all the parts of the plant, by means of which the burning, which only is applied to the extremity of one leaf, diffuſes its influence through every part of the ſhrub. If a drop of aquafortis be carefully laid upon a leaf of the ſenſitive plant, ſo as not to ſhake it in the leaſt, the leaf does not begin to move till the acrid liquor corrodes the ſubſtance of it; but at that time, not only that particular leaf, but all the leaves placed on the ſame footſtalk, cloſe themſelves up. The vapour of burning ſulphur has alſo this effect on many leaves at once, according as they are more or leſs expoſed to it; but a bottle of very acrid and ſulphureous ſpirit of vitriol, placed under the branches unſtopped, produces no ſuch effect. Wetting the leaves with ſpirit of wine has been obſerved alſo to have no effect, nor the rubbing oil of almonds over them; though this laſt application deſtroys many plants.

From the preceding experiments the following concluſions may be fairly drawn: 1. The contraction of the parts of the ſenſitive plant is occaſioned by an external force, and the contraction is in proportion to the force. 2. All bodies which can exert any force affect the ſenſitive plant; ſome by the touch or by agitation, as the wind, rain, &c.; ſome by chemical influence, as heat and cold. 3. Touching or agitating the plant produces a greater effect than an inciſion or cutting off a part, or by applying heat or cold.

Attempts have been made to explain theſe curious phenomena. Dr Darwin, in the notes to his admired poem, entitled, *The Botanic Garden*, lays it down as a principle, that "the ſleep of animals conſiſts in a ſuſpenſion of voluntary motion; and as vegetables are ſubject to ſleep as well as animals, there is reaſon to conclude (ſays he) that the various action of cloſing their petals and foliage may be juſtly aſcribed to a voluntary power; for without the faculty of volition ſleep would not have been neceſſary to them." Whether this definition of ſleep when applied to animals be juſt, we ſhall not inquire; but it is evident the ſuppoſed analogy between the ſleep of animals and the ſleep of plants has led Dr Darwin to admit this aſtoniſhing concluſion, that plants have volition. As volition preſuppoſes a mind or ſoul, it were to be wiſhed that he had given us ſome information concerning the nature of a vegetable ſoul, which can think and will. We ſuſpect, however, that this vegetable ſoul will turn out to be a mere mechanical or chemical one; for it is affected by external forces uniformly in the ſame way, its volition is merely paſſive, and never makes any ſucceſsful reſiſtance againſt thoſe cauſes by which it is influenced. All this is a mere abuſe of words. The ſleep of plants is a metaphorical expreſſion, and has not the leaſt reſemblance to the ſleep of animals. Plants are ſaid to ſleep when the flowers or leaves are contracted or folded together; but we never heard that there is any ſimilar contraction in the body of an animal during ſleep.

The fibres of vegetables have been compared with the muſcles of animals, and the motions of the ſenſitive plant have been ſuppoſed the ſame with muſcular motion. Between the fibres of vegetables and the muſcles of animals, however, there is not the leaſt ſimilarity. If muſcles be cut through, ſo as to be ſeparated from the joints to which they are attached, their powers are completely deſtroyed; but this is not the caſe with vegetable fibres. The following very ingenious experiment, which was communicated to us by a reſpectable member of the Univerſity of Edinburgh, is deciſive on this ſubject. He ſelected a growing poppy at that period of its growth, before unfolding, when the head and neck are bent down almoſt double. He cut the ſtalk where it was curved half through on the under ſide, and half

through

Sentence. through at a ſmall diſtance on the upper ſide, and half through in the middle point between the two ſections, ſo that the ends of the fibres were ſeparated from the ſtalk. Notwithſtanding theſe ſeveral cuttings on the neck, the poppy raiſed its head, and aſſumed a more erect poſition. There is, therefore, a complete diſtinction between muſcular motion and the motions of a plant, for no motion can take place in the limb of an animal when the muſcles of that limb are cut.

In fine, we look upon all attempts to explain the motions of plants as abſurd, and all reaſoning from ſuppoſed analogy between animals and vegetables as the ſource of wild conjecture, and not of ſound philoſophy. We view the contraction and expanſion of the ſenſitive plant in the ſame light as we do gravitation, chemical attraction, electricity, and magnetiſm, as a ſingular fact, the circumſtances of which we may be fully acquainted with, but muſt deſpair of underſtanding its cauſe.

What has been ſaid under this article chiefly refers to the *mimoſa ſenſitiva* and *pudica*. For a full account of the motions of vegetables in general, ſee *Vegetable Motion*, under the article Motion.

SENTENCE, in *Law*, a judgement paſſed in court by the judge in ſome proceſs, either civil or criminal. See Judgement.

Sentence, in *Grammar*, denotes a period, or a ſet of words comprehending ſome perfect ſenſe or ſentiment of the mind. The buſineſs of pointing is to diſtinguiſh the ſeveral parts and members of ſentences, ſo as to render the ſenſe thereof as clear, diſtinct, and full as poſſible. See Punctuation.

In every ſentence there are two parts neceſſarily required; a noun for the ſubject, and a definite verb: whatever is found more than theſe two, affects one of them, either immediately, or by the intervention of ſome other, whereby the firſt is affected.

Again, every ſentence is either ſimple or compound: a ſimple ſentence is that conſiſting of one ſingle ſubject, and one finite verb.—A compound ſentence contains ſeveral ſubjects and finite verbs, either expreſsly or implicitly.

A ſimple ſentence needs no point or diſtinction; only a period to cloſe it: as, "A good man loves virtue for itſelf."—In ſuch a ſentence, the ſeveral adjuncts affect either the ſubject or the verb in a different manner. Thus the word *good* expreſſes the quality of the ſubject, *virtue* the object of the action, and *for itſelf* the end thereof.—Now none of theſe adjuncts can be ſeparated from the reſt of the ſentence: for if one be, why ſhould not all the reſt? and if all be, the ſentence will be minced into almoſt as many parts as there are words.

But if ſeveral adjuncts be attributed in the ſame manner either to the ſubject or the verb, the ſentence becomes compound, and is to be divided into parts.

In every compound ſentence, as many ſubjects, or as many finite verbs as there are, either expreſsly or implied, ſo many diſtinctions may there be. Thus, "My hopes, fears, joys, pains, all centre in you." And thus Cicero. *Catilina abiit, exceſſit, evaſit, erupit.*—The reaſon of which pointing is obvious; for as many ſubjects or finite verbs as there are in a ſentence, ſo many members does it really contain. Whenever, therefore, there occur more nouns than verbs, or contrariwiſe, they are to be conceived as equal. Since, as every ſubject requires its verbs, ſo every verb requires its ſubject, wherewith it may agree: excepting, perhaps, in ſome figurative expreſſions.

Sentence, Sentiment.

SENTICOSÆ (from *ſentis*, a "briar or bramble"), the name of the 35th order in Linnæus's fragments of a natural method, conſiſting of roſe, bramble, and other plants, which reſemble them in port and external ſtructure. See Botany, *Natural Method*.

SENTIMENT, according to Lord Kames, is a term appropriated to ſuch thoughts as are prompted by paſſion. It differs from a perception; for a perception ſignifies the act by which we become conſcious of external objects. It differs from conſciouſneſs of an internal action, ſuch as thinking, ſuſpending thought, inclining, reſolving, willing, &c. And it differs from the conception of a relation among objects; a conception of that kind being termed *opinion*.

SENTIMENTS, in *Poetry*. To talk in the language of muſic, each paſſion has a certain tone, to which every ſentiment proceeding from it ought to be tuned with the greateſt accuracy: which is no eaſy work, eſpecially where ſuch harmony ought to be ſupported during the courſe of a long theatrical repreſentation. In order to reach ſuch delicacy of execution, it is neceſſary that a writer aſſume the preciſe character and paſſion of the perſonage repreſented; which requires an uncommon genius. But it is the only difficulty; for the writer, who, annihilating himſelf, can thus become another perſon, need be in no pain about the ſentiments that belong to the aſſumed character: theſe will flow without the leaſt ſtudy, or even preconception; and will frequently be as delightfully new to himſelf as to his reader. But if a lively picture even of a ſingle emotion require an effort of genius, how much greater the effort to compoſe a paſſionate dialogue with as many different tones of paſſion as there are ſpeakers? With what ductility of feeling muſt that writer be endued, who approaches perfection in ſuch a work; when it is neceſſary to aſſume different and even oppoſite characters and paſſions in the quickeſt ſucceſſion? Yet this work, difficult as it is, yields to that of compoſing a dialogue in genteel comedy, exhibiting characters without paſſion. The reaſon is, that the different tones of character are more delicate, and leſs in ſight, than thoſe of paſſion; and, accordingly, many writers, who have no genius for drawing characters, make a ſhift to repreſent, tolerably well, an ordinary paſſion in its ſimple movements. But of all works of this kind, what is truly the moſt difficult, is a characteriſtical dialogue upon any philoſophical ſubject; to interweave characters with reaſoning, by ſuiting to the character of each ſpeaker a peculiarity not only of thought but of expreſſion, requires the perfection of genius, taſte, and judgement.

How difficult dialogue-writing is, will be evident, even without reaſoning, from the miſerable compoſitions of that kind found without number in all languages. The art of mimicking any ſingularity in geſture or in voice, is a rare talent, though directed by ſight and hearing, the acuteſt and moſt lively of our external ſenſes: how much more rare muſt that talent, of imitating characters and internal emotions, tracing all their different tints, and repreſenting them in a lively manner by natural ſentiments properly expreſſed? The truth is, ſuch execution is too delicate for an ordinary genius;

Sentiments. and for that reason the bulk of writers, instead of expressing a passion as one does who feels it, content themselves with describing it in the language of a spectator. To awake passion by an internal effort merely, without any external cause, requires great sensibility; and yet that operation is necessary, not less to the writer than to the actor; because none but those who actually feel a passion can represent it to the life. The writer's part is the more complicated: he must add composition to passion: and must, in the quickest succession, adopt every different character. But a very humble flight of imagination may serve to convert a writer into a spectator, so as to figure, in some obscure manner, an action as passing in his sight and hearing. In that figured situation, being led naturally to write like a spectator, he entertains his readers with his own reflections, with cool description, and florid declamation; instead of making them eye-witnesses, as it were, to a real event, and to every movement of genuine passion. Thus most of our plays appear to be cast in the same mould; personages without character, the mere outlines of passion, a tiresome monotony, and a pompous declamatory style.

This descriptive manner of representing passion is a very cold entertainment; our sympathy is not raised by description; we must first be lulled into a dream of reality, and every thing must appear as passing in our sight. Unhappy is the player of genius who acts a part in what may be termed a *descriptive tragedy;* after assuming the very passion that is to be represented, how is he cramped in action, when he must utter, not the sentiments of the passion he feels, but a cold description in the language of a bystander? It is that imperfection, undoubtedly, in the bulk of our plays, which confines our stage almost entirely to Shakespeare, notwithstanding his many irregularities. In our late English tragedies, we sometimes find sentiments tolerably well adapted to a plain passion: but we must not in any of them expect a sentiment expressive of character: and, upon that very account, our late performances of the dramatic kind are for the most part intolerably insipid.

But it may be proper to illustrate this subject by examples. The first examples shall be of sentiments that appear the legitimate offspring of passion; to which shall be opposed what are descriptive only, and illegitimate; and in making this comparison, the instances shall be borrowed from Shakespeare and Corneille, who for genius in dramatic composition stand uppermost in the rolls of fame.

I. Shakespeare shall furnish the first example, being of sentiments dictated by a violent and perturbed passion:

Lear. ——————Filial ingratitude!
Is it not as if this mouth should tear this hand
For lifting food to't?—But I'll punish home;
No, I will weep no more.——In such a night,
To shut me out!——Pour on, I will endure.
In such a night as this! O Regan, Gonerill,
Your old kind father, whose frank heart gave all—
O! that way madness lies; let me shun that;
No more of that.——————
Kent. Good, my lord, enter here.
Lear. Prithee, go in thyself, seek thine own ease,
This tempest will not give me leave to ponder
On things would hurt me more:—but I'll go in;
In, boy, go first. You houseless poverty——
Nay, get thee in; I'll pray, and then I'll sleep——
Poor naked wretches, wheresoe'er you are,
That bide the pelting of this pitiless storm!
How shall your houseless heads, and unfed sides,
Your loop'd and window'd raggedness, defend you
From seasons such as these!——O I have ta'en
Too little care of this! take physic, Pomp;
Expose thyself to feel what wretches feel,
That thou may'st shake the superflux to them,
And show the heav'ns more just.

King Lear, act iii. sc. 5.

With regard to the French author, truth obliges us to acknowledge, that he describes in the style of a spectator, instead of expressing passion like one who feels it; which naturally betrays him into a tiresome monotony, and a pompous declamatory style. It is scarcely necessary to give examples, for he never varies from that tone. We shall, however, take two passages at a venture, in order to be confronted with those transcribed above. In the tragedy of Cinna, after the conspiracy was discovered, Æmilia, having nothing in view but racks and death to herself and her lover, receives a pardon from Augustus, attended with the brightest circumstances of magnanimity and tenderness. This is a lucky situation for representing the passions of surprise and gratitude in their different stages, which seem naturally to be what follow. These passions, raised at once to the utmost pitch, and being at first too big for utterance, must, for some moments, be expressed by violent gestures only: so soon as there is vent for words, the first expressions are broken and interrupted: at last, we ought to expect a tide of intermingled sentiments, occasioned by the fluctuation of the mind between the two passions. Æmilia is made to behave in a very different manner: with extreme coolness she describes her own situation, as if she were merely a spectator; or rather the poet takes the task off her hands:

Et je me rends, Seigneur, à ces hautes bontés:
Je recouvre la vûe auprès de leurs clartés.
Je connois mon forfait qui me sembloit justice;
Et ce que n'avoit pû la terreur du supplice,
Je sens naitre en mon ame un repentir puissant,
Et mon cœur en secret me dit, qu'il y consent.
Le ciel a résolu votre grandeur suprême;
Et pour preuve, Seigneur, je n'en veux que moi-même.
J'ose avec vanité me donner cet éclat,
Puisqu'il change mon cœur, qu'il veut changer l'état.
Ma haine va mourir, que j'ai crue immortelle;
Elle est morte, et ce cœur devient sujet fidele;
Et prenant désormais cette haine en horreur,
L'ardeur de vous servir succede à sa fureur.

Act v. sc. 3.

So much in general on the genuine sentiments of passion. We proceed to particular observations. And, first, passions seldom continue uniform any considerable time: they generally fluctuate, swelling and subsiding by turns, often in a quick succession; and the sentiments cannot be just unless they correspond to such fluctuation. Accordingly, a climax never shows better than in expressing a swelling passion: the following passages may suffice for an illustration.

Almeria.

Sentiments.

Almeria. ——— How haſt thou charm'd
The wildneſs of the waves and rocks to this;
That thus relenting they have giv'n thee back
To earth, to light and life, to love and me?
Mourning Bride, act i. ſc. 7.

I would not be the villain that thou think'ſt
For the whole ſpace that's in the tyrant's graſp,
And the rich earth to boot.
Macbeth, act iv. ſc. 4.

The following paſſage expreſſes finely the progreſs of conviction.

Let me not ſtir, nor breathe, leſt I diſſolve
That tender, lovely form, of painted air,
So like Almeria. Ha! it ſinks, it falls;
I'll catch it e'er it goes, and graſp her ſhade.
'Tis life! 'tis warm! 'tis ſhe! 'tis ſhe herſelf!
It is Almeria! 'tis, it is my wife!
Mourning Bride, act ii. ſc. 6.

In the progreſs of thought our reſolutions become more vigorous as well as our paſſions.

If ever I do yield or give conſent,
By any action, word, or thought, to wed
Another lord; may then juſt heav'n ſhow'r down, &c.
Mourning Bride, act i. ſc. 1.

And this leads to a ſecond obſervation, That the different ſtages of a paſſion, and its different directions, from birth to extinction, muſt be carefully repreſented in their order; becauſe otherwiſe the ſentiments, by being miſplaced, will appear forced and unnatural.—Reſentment, for example, when provoked by an atrocious injury, diſcharges itſelf firſt upon the author: ſentiments therefore of revenge come always firſt, and muſt in ſome meaſure be exhauſted before the perſon injured think of grieving for himſelf. In the Cid of Corneille, Don Diegue having been affronted in a cruel manner, expreſſes ſcarcely any ſentiment of revenge, but is totally occupied in contemplating the low ſituation to which he is reduced by the affront:

O rage! ô deſeſpoir! ô vieilleſſe ennemie!
N'ai-je donc tant vecu que pour cette infamie?
Et ne ſuis-je blanchi dans les travaux guerriers,
Que pour voir en un jour fletrit tant de lauriers?
Mon bras, qu'avec reſpect tout l'Eſpagne admire,
Mon bras qui tant de fois a ſauvé cet empire,
Tant de fois affermi le trône de ſon roi,
Trahit donc ma querelle, et ne fait rien pour moi!
O cruel ſouvenir de ma gloire paſſé!
Oeuvre de tant de jours en un jour effacée!
Nouvelle dignité fatale à mon bonheur!
Precipice élevé d'où tombe mon honneur!
Faut-il de votre éclat voir triompher le comte,
Et mourir ſans vengeance, ou vivre dans la honte?
Comte, ſois de mon prince à preſent gouverneur,
Ce haut rang n'admet point un homme ſans honneur;
Et ton jaloux orgueil par cet affront inſigne,
Malgré le choix du roi, m'en a ſû rendre indigne.
Et toi, de mes exploits glorieux inſtrument,
Mais d'un corps tout de glace inutile ornement,
Fer jadis tant à craindre, et qui dans cette offenſe,
M'as ſervi de parade, et non pas de defenſe,
Va, quitte deſormais le dernier des humains,
Paſſe pour me venger en de meilleures mains.
Le Cid, act i. ſc. 7.

Sentiments.

Theſe ſentiments are certainly not the firſt that are ſuggeſted by the paſſion of reſentment. As the firſt movements of reſentment are always directed to its object, the very ſame is the caſe of grief. Yet with relation to the ſudden and ſevere diſtemper that ſeized Alexander bathing in the river Cydnus, Quintus Curtius deſcribes the firſt emotions of the army as directed to themſelves, lamenting that they were left without a leader, far from home, and had ſcarce any hopes of returning in ſafety: their king's diſtreſs, which muſt naturally have been their firſt concern, occupies them but in the ſecond place according to that author. In the Aminta of Taſſo, Sylvia, upon a report of her lover's death, which ſhe believed certain, inſtead of bemoaning the loſs of her beloved, turns her thoughts upon herſelf, and wonders her heart does not break:

Ohime, ben ſon di ſaſſo,
Poi che queſta novella non m'uccide.
Act iv. ſc. 2.

In the tragedy of Jane Shore, Alicia, in the full purpoſe of deſtroying her rival, has the following reflection:

Oh Jealouſy! thou bane of pleaſing friendſhip,
Thou worſt invader of our tender boſoms;
How does thy rancour poiſon all our ſoftneſs,
And turn our gentle nature into bitterneſs!
See where ſhe comes! Once my heart's deareſt bleſſing,
Now my chang'd eyes are blaſted with her beauty,
Loathe that known face, and ſicken to behold her.
Act iii. ſc. 1.

Theſe are the reflections of a cool ſpectator. A paſſion, while it has the aſcendant, and is freely indulged, ſuggeſts not to the perſon who feels it any ſentiment to its own prejudice: reflections like the foregoing occur not readily till the paſſion has ſpent its vigour.

A perſon ſometimes is agitated at once by different paſſions; and the mind in that caſe, vibrating like a pendulum, vents itſelf in ſentiments that partake of the ſame vibration. This we give as a third obſervation:

Queen. Would I had never trod this Engliſh earth,
Or felt the flatteries that grow upon it!
Ye've angels faces, but heav'n knows your hearts.
What ſhall become of me now? wretched lady!
I am the moſt unhappy woman living.
Alas! poor wenches, where are now your fortunes?
[*To her women.*
Shipwreck'd upon a kingdom, where no pity,
No friends, no hope, no kindred, weep for me:
Almoſt no grave allow'd me.
Henry VIII. act iii. ſc. 1.

Othello. Oh devil, devil!
If that the earth could teem with woman's tears,
Each drop ſhe falls would prove a crocodile.
Out of my ſight!
Deſdemona. I will not ſtay t'offend you. [*Going.*
Lodovico. Truly, an obedient lady:
I do beſeech your lordſhip, call her back.
Oth. Miſtreſs——

Deſ.

Sentiments.

Def. My lord.

Oth. What would you with her, Sir?

Lod. Who, I, my lord?

Oth. Ay; you did wish that I would make her turn.
Sir, she can turn and turn, and yet go on;
And turn again. And she can weep, Sir, weep;
And she's obedient: as you say, obedient:
Very obedient—proceed you in your tears—
Concerning this, Sir,—oh well painted passion!—
I am commanded home—get you away,
I'll send for you anon—Sir, I obey the mandate,
And will return to Venice.——Hence, avaunt!
[*Exit* Desdemona.
Othello, act iv. sc. 6.

Æmilia. Oh! my good lord, I would speak a word with you.

Othello. Yes, 'tis Æmilia—By and by.—She's dead.
'Tis like she comes to speak of Cassio's death;
The noise was high.—Ha! no more moving?
Still as the grave. Shall she come in? wer't good?
I think she stirs again—No—what's the best?
If she come in, she'll, sure, speak to my wife:
My wife! my wife! what wife? I have no wife;
Oh insupportable! oh heavy hour!
Othello, act v. sc. 7.

A fourth observation is, That nature, which gave us passions, and made them extremely beneficial when moderate, intended undoubtedly that they should be subjected to the government of reason and conscience. It is therefore against the order of nature, that passion in any case should take the lead in contradiction to reason and conscience: such a state of mind is a sort of anarchy which every one is ashamed of and endeavours to hide or dissemble. Even love, however laudable, is attended with a conscious shame when it becomes immoderate: it is covered from the world, and disclosed only to the beloved object:

Et que l'amour souvent de remors combattu
Paroisse une foiblesse, et non une vertu.
BOILEAU, *l'Art Poet.* chant. iii. l. 101.

O, they love least that let men know they love.
Two Gentleman of Verona, act i. sc. 3.

Hence a capital rule in the representation of immoderate passions, that they ought to be hid or dissembled as much as possible. And this holds in an especial manner with respect to criminal passions: one never counsels the commission of a crime in plain terms; guilt must not appear in its native colours, even in thought; the proposal must be made by hints, and by representing the action in some favourable light. Of the propriety of sentiment upon such an occasion, Shakespeare, in the *Tempest*, has given us a beautiful example, in a speech by the usurping duke of Milan, advising Sebastian to murder his brother the king of Naples:

Antonio. ——————What might,
Worthy Sebastian,—O, what might—no more.
And yet, methinks, I see it in thy face
What thou shouldst be: the occasion speaks thee, and
My strong imagination sees a crown
Dropping upon thy head. Act ii. sc. 2.

A picture of this kind, perhaps still finer, is exhibited in *King John*, where that tyrant solicits (act iii. sc. 5.) Hubert to murder the young prince Arthur; but it is too long to be inserted here.

Sentiments

II. As things are best illustrated by their contraries, we proceed to faulty sentiments, disdaining to be indebted for examples to any but the most approved authors. The first class shall consist of sentiments that accord not with the passion; or, in other words, sentiments that the passion does not naturally suggest. In the second class shall be ranged sentiments that may belong to an ordinary passion, but unsuitable to it as tinctured by a singular character. Thoughts that properly are not sentiments, but rather descriptions, make a third. Sentiments that belong to the passion represented, but are faulty as being introduced too early or too late, make a fourth. Vicious sentiments exposed in their native dress, instead of being concealed or disguised, make a fifth. And in the last class shall be collected sentiments suited to no character nor passion, and therefore unnatural.

The *first* class contains faulty sentiments of various kinds, which we shall endeavour to distinguish from each other.

1. Of sentiments that are faulty by being above the tone of the passion, the following may serve as an example:

Othello.——————O my soul's joy!
If after every tempest come such calms,
May the winds blow till they have waken'd death:
And let the labouring bark climb hills of seas
Olympus high, and duck again as low
As hell's from heaven? *Othello*, act ii. sc. 6.

This sentiment may be suggested by violent and inflamed passion; but is not suited to the satisfaction, however great, that one feels upon escaping danger.

2. Instance of sentiments below the tone of the passion. Ptolemy, by putting Pompey to death, having incurred the displeasure of Cæsar, was in the utmost dread of being dethroned: in that agitating situation, Corneille makes him utter a speech full of cool reflection, that is in no degree expressive of the passion.

Ah! si je t'avois crû, je n'aurois pas de maitre,
Je serois dans le trône où le ciel m'a fait naître;
Mais c'est une imprudence assez commune aux rois,
D'écouter trop d'avis, et se tromper au choix.
Le Destin les aveugle au bord du précipice,
Ou si quelque lumiere en leur ame se glisse,
Cette fausse clarté dont il les eblouit,
Le plonge dans une gouffre, et puis s'evanouit.
La Mort de Pompée, act iv. sc. 1.

3. Sentiments that agree not with the tone of the passion; as where a pleasant sentiment is grafted upon a painful passion, or the contrary. In the following instances, the sentiments are too gay for a serious passion:

No happier task these faded eyes pursue;
To read and weep is all they now can do.
Eloisa to Abelard, l. 47.

Again;

Heav'n first taught letters for some wretch's aid,
Some banish'd lover, or some captive maid:

They

Sentiments.

They live, they speak, they breathe what love inspires,
Warm from the soul, and faithful to its fires;
The virgin's wish without her fears impart,
Excuse the blush, and pour out all the heart;
Speed the soft intercourse from soul to soul,
And waft a sigh from Indus to the pole.
Eloisa to Abelard, l. 51.

These thoughts are pretty: they suit Pope, but not Eloisa.

Satan, enraged by a threatening of the angel Gabriel, answers thus:

Then when I am thy captive, talk of chains,
Proud limitary cherub; but ere then
Far heavier load thyself expect to feel
From my prevailing arm, though heaven's King
Ride on thy wings, and thou with thy compeers,
Us'd to the yoke, draw'st his triumphant wheels
In progress thro' the road of heav'n *star pav'd.*
Paradise Lost, book iv.

The concluding epithet forms a grand and delightful image, which cannot be the genuine offspring of rage.

4. Sentiments too artificial for a serious passion. The first example is a speech of Percy expiring.

O, Harry, thou hast robb'd me of my growth:
I better brook the loss of brittle life,
Than those proud titles thou hast won of me:
They wound my thoughts worse than thy sword my flesh.
But thought's the slave of life, and life time's fool;
And time, that takes survey of all the world,
Must have a stop.
First Part, Henry IV. act v. sc. 9.

The sentiments of the *Mourning Bride* are for the most part no less delicate than just copies of nature: in the following exception the picture is beautiful, but too artful to be suggested by severe grief.

Almeria. O no! Time gives increase to my afflictions.
The circling hours, that gather all the woes
Which are diffus'd through the revolving year,
Come heavy laden with th' oppressive weight
To me; with me, successively, they leave
The sighs, the tears, the groans, the restless cares,
And all the damps of grief, that did retard their flight;
They shake their downy wings, and scatter all
The dire collected dews on my poor head;
Then fly with joy and swiftness from me. Act i. sc. 1.

In the same play, Almeria seeing a dead body, which she took to be Alphonso's, expresses sentiments strained and artificial, which nature suggests not to any person upon such an occasion:

Had they or hearts or eyes, that did this deed?
Could eyes endure to guide such cruel hands?
Are not my eyes guilty alike with theirs,
That thus can gaze, and yet not turn to stone?
—I do not weep! The springs of tears are dry'd,
And of a sudden I am calm, as if
All things were well; and yet my husband's murder'd!
Yes, yes, I know to mourn: I'll sluice this heart,
The source of wo, and let the torrent in.
Act v. sc. 11.

Pope's elegy to the memory of an unfortunate lady, expresses delicately the most tender concern and sorrow that one can feel for the deplorable fate of a person of worth. Such a poem, deeply serious and pathetic, rejects with disdain all fiction. Upon that account, the following passage deserves no quarter; for it is not the language of the heart, but of the imagination indulging its flights at ease, and by that means is eminently discordant with the subject. It would be a still more severe censure, if it should be ascribed to imitation, copying indiscreetly what has been said by others:

What though no weeping loves thy ashes grace,
Nor polish'd marble emulate thy face?
What though no sacred earth allow thee room,
Nor hallow'd dirge be mutter'd o'er thy tomb?
Yet shall thy grave with rising flow'rs be drest,
And the green turf lie lightly on thy breast:
There shall the morn her earliest tears bestow,
There the first roses of the year shall blow;
While angels with their silver wings o'ershade
The ground, now sacred by thy relics made.

5. Fanciful or finical sentiments. Sentiments that degenerate into point or conceit, however they may amuse in an idle hour, can never be the offspring of any serious or important passion. In the *Jerusalem* of Tasso, Tancred, after a single combat, spent with fatigue and loss of blood, falls into a swoon; in which situation, understood to be dead, he is discovered by Erminia, who was in love with him to distraction. A more happy situation cannot be imagined, to raise grief in an instant to its highest pitch; and yet, in venting her sorrow, she descends most abominably into antithesis and conceit even of the lowest kind:

E in lui versò d'inefficabil vena
Lacrime, e voce di sospiri mista.
In che misero punto hor qui me mena
Fortuna? a che veduta amara e trista?
Dopo gran tempo i' ti ritrovo à pena
Tancredi, e ti riveggio, e non son vista
Vista non son da te, benche presente
T' trovando ti perdo eternamente.
Canto xix. st. 105.

Armida's lamentation respecting her lover Rinaldo is in the same vicious taste. *Vid.* canto xx. stan. 124, 125. 126.

Queen. Give me no help in lamentation,
I am not barren to bring forth complaints:
All springs reduce their currents to mine eyes,
That I, being govern'd by the wat'ry moon,
May send forth plenteous tears to drown the world,
Ah, for my husband, for my dear lord Edward.
King Richard III. act ii. sc. 2.

Jane Shore utters her last breath in a witty conceit.

Then all is well, and I shall sleep in peace——
'Tis very dark, and I have lost you now——
Was there not something I would have bequeath'd you

But I have nothing left me to beſtow,
Nothing but one ſad ſigh. Oh mercy, Heav'n! [*Dies.*
Act v.

Guilford to Lady Jane Gray, when both were condemn'd to die:

Thou ſtand'ſt unmov'd;
Calm temper ſits upon thy beauteous brow;
Thy eyes that flow'd ſo faſt for Edward's loſs,
Gaze unconcern'd upon the ruin round thee,
As if thou had'ſt reſolv'd to brave thy fate,
And triumph in the midſt of deſolation.
Ha! ſee, it ſwells, the liquid cryſtal riſes,
It ſtarts in ſpite of thee——but I will catch it,
Nor let the earth be wet with dew ſo rich.
Lady Jane Gray, act iv. near the end.

The concluding ſentiment is altogether finical, unſuitable to the importance of the occaſion, and even to the dignity of the paſſion of love.

Corneille, in his *Examen of the Cid*, anſwering an objection, That his ſentiments are ſometimes too much refined for perſons in deep diſtreſs, obſerves, that if poets did not indulge ſentiments more ingenious or refined than are prompted by paſſion, their performances would often be low, and extreme grief would never ſuggeſt but exclamations merely. This is in plain language to aſſert, that forced thoughts are more agreeable than thoſe that are natural, and ought to be preferred.

The *ſecond* claſs is of ſentiments that may belong to an ordinary paſſion, but are not perfectly concordant with it, as tinctured by a ſingular character.

In the laſt act of that excellent comedy *The Careleſs Huſband*, Lady Eaſy, upon Sir Charles's reformation, is made to expreſs more violent and turbulent ſentiments of joy than are conſiſtent with the mildneſs of her character.

Lady Eaſy. O the ſoft treaſure! O the dear reward of long-deſiring love.—Thus! thus to have you mine, is ſomething more than happineſs; 'tis double life, and madneſs of abounding joy.

The following inſtances are deſcriptions rather than ſentiments, which compoſe a *third* claſs.

Of this deſcriptive manner of painting the paſſions, there is in the *Hippolytus* of Euripides, act v. an illuſtrious inſtance, viz. the ſpeech of Theſeus, upon hearing of his ſon's diſmal exit. In Racine's tragedy of *Eſther*, the queen hearing of the decree iſſued againſt her people, inſtead of expreſſing ſentiments ſuitable to the occaſion, turns her attention upon herſelf, and deſcribes with accuracy her own ſituation.

Juſte ciel! tout mon ſang dans mes veines ſe glace.
Act i. ſc. 3.

Again,

Aman. C'en eſt fait. Mon orgueil eſt forcé de plier.
L'inexorable Amen eſt reduit à prier.
Eſther, act iii. ſc. 5.

Athalie. Quel prodige nouveau me trouble et m'embarraſſe?
La douceur de ſa voix, ſon enfance, ſa grace,
Font inſenſiblement à mon inimitié
Succeder——Je ſerois ſenſible à la pitié?
Athalie, act ii. ſc. 7.

Titus. O de ma paſſion fureur deſeſperée!
Brutus of Voltaire, act iii. ſc. 6.

What other are the foregoing inſtances but deſcribing the paſſion another feels?

The *fourth* claſs is of ſentiments expreſſed too early or too late.

Some examples mentioned above belong to this claſs. Add the following from *Venice Preſerv'd*, act v. at the cloſe of the ſcene between Belvidera and her father Priuli. The account given by Belvidera of the danger ſhe was in, and of her huſband's threatening to murder her, ought naturally to have alarmed her relenting father, and to have made him expreſs the moſt perturbed ſentiments. Inſtead of which, he diſſolves into tenderneſs and love for his daughter, as if he had already delivered her from danger, and as if there were a perfect tranquillity:

Canſt thou forgive me all my follies paſt!
I'll henceforth be indeed a father; never,
Never more thus expoſe, but cheriſh thee,
Dear as the vital warmth that feeds my life,
Dear as thoſe eyes that weep in fondneſs o'er thee:
Peace to thy heart.

Immoral ſentiments expoſed in their native colours, inſtead of being concealed or diſguiſed, compoſe the *fifth* claſs.

The Lady Macbeth, projecting the death of the king, has the following ſoliloquy:

————The raven himſelf's not hoarſe
That croaks the fatal entrance of Duncan
Under my battlements. Come, all you ſpirits
That tend on mortal thoughts, unſex me here,
And fill me from the crown to the toe, top full
Of direſt cruelty; make thick my blood,
Stop up th' acceſs and paſſage to remorſe,
That no compunctious viſitings of nature
Shake my fell purpoſe. *Macbeth*, act i. ſc. 7.

This ſpeech is not natural. A treacherous murder was never perpetrated even by the moſt hardened miſcreant without compunction: and that the lady here muſt have been in horrible agitation, appears from her invoking the infernal ſpirits to fill her with cruelty, and to ſtop up all avenues to remorſe. But in that ſtate of mind it is a never-failing artifice of ſelf-deceit to draw the thickeſt veil over the wicked action, and to extenuate it by all the circumſtances that imagination can ſuggeſt: and if the crime cannot bear diſguiſe, the next attempt is to thruſt it out of mind altogether, and to ruſh on to action without thought. This laſt was the huſband's method.

Strange things I have in head, that will to hand;
Which muſt be acted ere they muſt be ſcann'd.
Act iii. ſc. 5.

The lady follows neither of theſe courſes, but in a deliberate manner endeavours to fortify her heart in the commiſſion of an execrable crime, without even attempting to colour it. This, we think, is not natural; we hope

hope there is no ſuch wretch to be found as is here repreſented.

The *laſt* claſs comprehends ſentiments that are unnatural, as being ſuited to no character nor paſſion. Theſe may be ſubdivided into three branches: firſt, ſentiments unſuitable to the conſtitution of man, and to the laws of his nature; ſecond, inconſiſtent ſentiments; third, ſentiments that are pure rant and extravagance.

When the fable is of human affairs, every event, every incident, and every circumſtance, ought to be natural, otherwiſe the imitation is imperfect. But an imperfect imitation is a venial fault, compared with that of running croſs to nature. In the *Hippolytus* of Euripides (act iv. ſc. 5.), Hippolytus, wiſhing for another ſelf in his own ſituation, "How much (ſays he) ſhould I be touched with his misfortune!" as if it were natural to grieve more for the misfortune of another than for one's own.

Oſmyn. Yet I behold her—yet—and now no more.
Turn your lights inward, eyes, and view my thoughts;
So ſhall you ſtill behold her—'twill not be.
O impotence of ſight! mechanic ſenſe
Which to exterior objects ow'ſt thy faculty,
Not ſeeing of election, but neceſſity.
Thus do our eyes, as do all common mirrors,
Succeſſively reflect ſucceeding images.
Nor what they would, but muſt; a ſtar or toad;
Juſt as the hand of chance adminiſters!

Mourning Bride, act ii. ſc. 8.

No man in his ſenſes, ever thought of applying his eyes to diſcover what paſſes in his mind; far leſs of blaming his eyes for not ſeeing a thought or idea. In Moliere's *l'Avare* (act iv. ſc. 7.) Harpagon, being robbed of his money, ſeizes himſelf by the arm, miſtaking it for that of the robber. And again he expreſſes himſelf as follow:

Je veux aller querir la juſtice, et faire donner la queſtion à toute ma maiſon; à ſervantes, à valets, à fils, à fille, et à moi auſſi.

This is ſo abſurd as ſcarcely to provoke a ſmile, if it be not at the author.

Of the ſecond branch the following example may ſuffice:

——————Now bid me run,
And I will ſtrive with things *impoſſible*,
Yea, get the better of them.

Julius Cæſar, act ii. ſc. 3.

Of the third branch, take the following ſamples. Lucan, talking of Pompey's ſepulchre,

—————— Romanum nomen, et omne
Imperium magno eſt tumuli modus. Obrue ſaxa
Crimine plena deûm. Si tota eſt Herculis Oete,
Et juga tota vacant Bromio Nyſeia; quare
Unus in Egypto Magno lapis? Omnia Lagi
Rura tenere poteſt, ſi nullo ceſpite nomen
Hæſerit. Erremus populi, cinerumque tuorum,
Magne, metu nullas Nili calcemus arenas.

Lib. viii. l. 793.

Thus, in Rowe's tranſlation.

Where there are ſeas, or air, or earth, or ſkies,
Where'er Rome's empire ſtretches, Pompey lies.
Far be the vile memorial then convey'd!
Nor let this ſtone the partial gods upbraid.
Shall Hercules all Oeta's heights demand,
And Nyſa's hill for Bacchus only ſtand;
While one poor pebble is the warrior's doom
That fought the cauſe of liberty and Rome?
If Fate decrees he muſt in Egypt lie,
Let the whole fertile realm his grave ſupply,
Yield the wide country to his awful ſhade,
Nor let us dare on any part to tread,
Fearful we violate the mighty dead.

The following paſſages are pure rant. Coriolanus, ſpeaking to his mother,

What is this?
Your knees to me? to your corrected ſon?
Then let the pebbles on the hungry beach
Fillop the ſtars: then let the mutinous winds
Strike the proud cedars 'gainſt the fiery ſun:
Murd'ring impoſſibility, to make
What cannot be, ſlight work.

Coriolanus, act i. ſc. 3.

Cæſar. ———Danger knows full well,
That Cæſar is more dangerous than he.
We were two lions litter'd in one day,
And I the elder and more terrible.

Julius Cæſar, act ii. ſc. 4.

Ventidius. But you, ere love miſled your wand'ring eyes,
Were ſure the chief and beſt of human race,
Fram'd in the very pride and boaſt of nature,
So perfect, that the gods who form'd you wonder'd
At their own ſkill, and cry'd, A lucky hit
Has mended our deſign. DRYDEN, *All for Love*, act i.

Not to talk of the impiety of this ſentiment, it is ludicrous inſtead of being lofty.

The famous epitaph on Raphael is not leſs abſurd than any of the foregoing paſſages:

Raphael, timuit, quo ſoſpite, vinci,
Rerum magna parens, et moriente mori.

Imitated by Pope, in his epitaph on Sir Godfrey Kneller:

Living, great Nature fear'd he might outvie
Her works; and dying, fears herſelf may die.

Such is the force of imitation; for Pope of himſelf would never have been guilty of a thought ſo extravagant.

SENTINEL, or SENTRY, in military affairs, a private ſoldier placed in ſome poſt to watch the approach of the enemy, to prevent ſurpriſes, to ſtop ſuch as would paſs without orders or diſcovering who they are. They are placed before the arms of all guards, at the tents and doors of general officers, colonels of regiments, &c.

SENTINEL Perdu, a ſoldier poſted near an enemy, or in ſome very dangerous poſt where he is in hazard of being loſt.

All ſentinels are to be vigilant on their poſts; neither are they to ſing, ſmoke tobacco, nor ſuffer any noiſe to be made near them. They are to have a watchful eye over the things committed to their charge. They are not to ſuffer any light to remain, or any fire to be made,

made, near their posts in the night-time; neither is any sentry to be relieved or removed from his post but by the corporal of the guard. They are not to suffer any one to touch or handle their arms, or in the night-time to come within ten yards of their post.

No person is to strike or abuse a sentry on his post; but when he has committed a crime, he is to be relieved, and then punished according to the rules and articles of war.

A sentinel, on his post in the night, is to know nobody but by the counter sign: when he challenges, and is answered, *Relief*, he calls out, *Stand, relief! advance, corporal!* upon which the corporal halts his men, and advances alone within a yard of the sentry's firelock (first ordering his party to rest, on which the sentry does the same), and gives him the counter-sign, taking care that no one hear it.

SEPIA, the CUTTLE-FISH, a genus of animals belonging to the class of vermes. See HELMINTHOLOGY *Index*.

The officinal cuttle affords the cuttle-bone of the shops, which was formerly used as an absorbent. The bones are frequently flung on all our shores; the animal very rarely. The conger eels, it is said, bite off their arms, or feet; but it is added they grow again, as does the lizard's tail (Plin. ix. 29.). They are preyed upon by the plaise. This fish emits (in common with the other species), when alarmed or pursued, the black liquor which the ancients supposed darkened the circumambient wave, and concealed it from the enemy.

The endanger'd cuttle thus evades his fears,
And native hoards of fluid safety bears.
A pitchy ink peculiar glands supply,
Whose shades the sharpest beam of light defy.
Pursu'd, he bids the sable fountains flow,
And, wrapt in clouds, eludes th' impending foe.
The fish retreats unseen, while self-born night,
With pious shade befriends her parent's flight.

The ancients sometimes made use of it instead of ink. Persius mentions the species in his description of the noble student.

Jam liber, et bicolor positis membrana capillis,
Inque manus chartæ, nodosque venit arundo.
Tum querimur, crassus calamo quod pendeat humor;
Nigra quod infusa vanescat sepia *lympha.*
At length, his book he spreads, his pen he takes;
His papers here in learned order lays,
And there his parchment's smoother side displays.
But oh! what crosses wait on studious men!
The *cuttle's* juice hangs clotted at our pen.
In all my life such stuff I never knew,
So gummy thick—Dilute it, it will do.
Nay, now 'tis water! DRYDEN.

This animal was esteemed a delicacy by the ancients, and is eaten even at present by the Italians. Rondeletius gives us two receipts for the dressing, which may be continued to this day. Athenæus also leaves us the method of making an antique cuttle fish sausage; and we learn from Aristotle, that those animals are in highest season when pregnant.

SEPIARIÆ, (from *sepes*, "a hedge"), the name of the 44th order of Linnæus's Fragments of a Natural Method, consisting of a beautiful collection of woody plants, some of which, from their size and elegance, are very proper furniture for hedges. See BOTANY *Index*.

SEPS, a species of LACERTA. See ERPETOLOGY *Index*.

SEPTARIÆ, in *Natural History*, an old term for a variety of iron-stone, called also *ludus Helmontii*. This mineral is of a round compressed form, and is internally divided by septa or thin partitions of lime spar or pyrites; hence the name.

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

SEPTEMBER, the ninth month of the year, consisting of thirty days; it took its name as being the seventh month, reckoning from March, with which the Romans began their year.

SEPTENNIAL, any thing lasting seven years.

SEPTENNIAL Elections. Blackstone, in his Commentaries, vol. i. p. 189. says, (after observing that the utmost extent of time allowed the same parliament to sit by the stat. 6. W. and M. c. 2. was three years), "But, by the statute 1 Geo. I. st. st. 2. c. 38. (in order *professedly* to prevent the great and continued expences of frequent elections, and the violent heats and animosities consequent thereupon, and for the peace and security of the government, just then recovering from the late rebellion), this term was prolonged to seven years; and what alone is an instance of the vast authority of parliament, the very same house that was chosen for three years enacted its own continuance for seven."

SEPTENTRIO, in *Astronomy*, a constellation, more usually called *ursa minor*.

In cosmography, the term *septentrio* denotes the same with *north*: and hence septentrional is applied to any thing belonging to the north; as *septentrional signs, parallels*, &c.

SEPTICS, are those substances which promote putrefaction, chiefly the calcareous earths, magnesia, and testaceous powders. From the many curious experiments made by Sir John Pringle to ascertain the *septic* and *antiseptic* virtues of natural bodies, it appears that there are very few substances of a truly *septic* nature. Those commonly reputed such by authors, as the alkaline and volatile salts, he found to be no wise *septic*. However, he discovered some, where it seemed least likely to find any such quality; these were chalk, common salt, and testaceous powders. He mixed twenty grains of crabs eyes, prepared with six drams of ox's gall, and an equal quantity of water. Into another phial he put an equal quantity of gall and water, but no crabs-eyes. Both these mixtures being placed in the furnace, the putrefaction began much sooner, where the powder was, than in the other phial. On making a like experiment with chalk, its *septic* virtue was found to be much greater than that of the crabs-eyes: nay, what the doctor never met with before, in a mixture of two drams of flesh, with two ounces of water and thirty grains of prepared chalk, the flesh was resolved into a perfect mucus in a few days.

To try whether the testaceous powders would also dissolve vegetable substances, the doctor mixed them with barley and water, and compared this mixture with another of barley and water alone. After a long maceration cerated by a fire, the plain water was found to ſwell the barley, and turn mucilaginous and ſour; but that with the powder kept the grain to its natural ſize, and though it ſoftened it, yet made no mucilage, and remained ſweet.

Nothing could be more unexpected, than to find ſea ſalt a haſtener of putrefaction; but the fact is thus; one dram of ſalt preſerves two drams of freſh beef in two ounces of water, above thirty hours, uncorrupted, in a heat equal to that of the human body; or, which is the ſame thing, this quantity of ſalt keeps fleſh ſweet twenty hours longer than pure water; but then half a dram of ſalt does not preſerve it above two hours longer. Twenty-five grains have little or no antiſeptic virtue, and ten, fifteen, or even twenty grains, manifeſtly both haſten and heighten the corruption. The quantity which had the moſt putrefying quality, was found to be about ten grains to the above proportion of fleſh and water.

Many inferences might be drawn from this experiment: one is, that ſince ſalt is never taken in aliment beyond the proportion of the corrupting quantities, it would appear that it is ſubſervient to digeſtion chiefly by its *ſeptic* virtue, that is, by ſoftening and reſolving meats; an action very different from what is commonly believed.

It is to be obſerved, that the above experiments were made with the ſalt kept for domeſtic uſes. See Pringle's Obſerv. on the Diſeaſes of the army, p. 348, et ſeq.

SEPTIZON, or SEPTIZONIUM, in Roman antiquity, a celebrated mauſoleum, built by Septimius Severus, in the tenth region of the city of Rome: it was ſo called from *ſeptem* and *zona*, by reaſon it conſiſted of ſeven ſtories, each of which was ſurrounded by a row of columns.

SEPTUAGESIMA, in the kalendar, denotes the third Sunday before Lent, or before Quadrageſima Sunday: ſuppoſed by ſome to take its name from its being about ſeventy days before Eaſter.

SEPTUAGINT, the name given to a Greek verſion of the books of the Old Teſtament, from its being ſuppoſed to be the work of ſeventy Jews, who are uſually called the *ſeventy interpreters*, becauſe ſeventy is a round number.

The hiſtory of this verſion is expreſsly written by Ariſtæas, an officer of the guards to Ptolemy Philadelphus, the ſubſtance of whoſe account is as follows:— Ptolemy having erected a fine library at Alexandria, which he took care to fill with the moſt curious and valuable books from all parts of the world, was informed that the Jews had one containing the laws of Moſes, and the hiſtory of that people; and being deſirous of enriching his library with a Greek tranſlation of it, applied to the high-prieſt of the Jews; and to engage him to comply with his requeſt, ſet at liberty all the Jews whom his father Ptolemy Soter had reduced to ſlavery. After ſuch a ſtep, he eaſily obtained what he deſired; Eleazar the Jewiſh high-prieſt ſent back his ambaſſadors with an exact copy of the Moſaical law, written in letters of gold, and ſix elders of each tribe, in all ſeventy-two; who were received with marks of reſpect by the king, and then conducted into the iſle of Pharos, where they were lodged in a houſe prepared for their reception, and ſupplied with every thing neceſſary. They ſet about the tranſlation without loſs of time, and finiſhed it in ſeventy-two days; and the whole being read in the preſence of the king, he admired the profound wiſdom of the laws of Moſes: and ſent back the deputies laden with preſents, for themſelves, the high-prieſt, and the temple.

Ariſtobulus, who was tutor to Ptolemy Phyſcon, Philo who lived in our Saviour's time, and was contemporary with the apoſtles, and Joſephus, ſpeak of this tranſlation as made by ſeventy two interpreters, by the care of Demetrius Phalereus in the reign of Ptolemy Philadelphus. All the Chriſtian writers, during the firſt 15 centuries of the Chriſtian era, have admitted this account of the Septuagint as an undoubted fact. But ſince the reformation, critics have boldly called it in queſtion, becauſe it was attended with circumſtances which they think inconſiſtent, or, at leaſt, improbable. Du Pin has aſked, why were ſeventy-two interpreters employed, ſince twelve would have been ſufficient? Such an objection is trifling. We may as well aſk, why did King James I. employ fifty-four tranſlators in rendering the Bible into Engliſh, ſince Du Pin thinks twelve would have been ſufficient?

1. Prideaux objects, that the Septuagint is not written in the Jewiſh, but in the Alexandrian, dialect; and could not therefore be the work of natives of Paleſtine. But theſe dialects were probably at that time the ſame, for both Jews and Alexandrians had received the Greek language from the Macedonians about 50 years before.

2. Prideaux farther contends, that all the books of the Old Teſtament could not be tranſlated at the ſame time; for they exhibit great difference of ſtyle. To this it is ſufficient to reply, that they were the work of ſeventy-two men, each of whom had ſeperate portions aſſigned them.

3. The Dean alſo urges, that Ariſtæas, Ariſtobulus, Philo, and Joſephus, all directly tell us, that the law was tranſlated without mentioning any of the other ſacred books. But nothing was more common among writers of the Jewiſh nation than to give this name to the Scriptures as a whole. In the New Teſtament, law is uſed as ſynonymous with what we call the Old Teſtament. Beſides, it is expreſsly ſaid by Ariſtobulus, in a fragment quoted by Euſebius (*Præp. Evan.* l. 1.), that the whole Sacred Scripture was rightly tranſlated through the means of Demetrius Phalereus, and by the command of Philadelphus. Joſephus indeed, ſays the learned Dean, aſſerts, in the preface to his Antiquities, that the Jewiſh interpreters did not tranſlate for Ptolemy the whole Scriptures, but the law only. Here the evidence is contradictory, and we have to determine, whether Ariſtobulus or Joſephus be moſt worthy of credit. We do not mean, however, to accuſe either of forgery, but only to inquire which had the beſt opportunities of knowing the truth. Ariſtobulus was an Alexandrian Jew, tutor to an Egyptian king, and lived within 100 years after the tranſlation was made, and certainly had acceſs to ſee it in the royal library. Joſephus was a native of Paleſtine, and lived not until 300 years or more after the tranſlation was made, and many years after it was burnt along with the whole library of Alexandria in the wars of Julius Cæſar. Suppoſing the veracity of theſe two writers equal, as we have no proof of the contrary, which of them ought we to conſider as the beſt evidence? Ari-

Septuagint.

ſtobulus ſurely. Prideaux, indeed, ſeems doubtful whether there was ever ſuch a man; and Dr Hody ſuppoſes that the Commentaries on the five books of Moſes, which bear the name of Ariſtobulus, were a forgery of the ſecond century. To prove the exiſtence of any human being, who lived 2000 years before us, and did not perform ſuch works as no mere man ever performed, is a taſk which we are not diſpoſed to undertake; and we believe it would not be leſs difficult to prove that Philo and Joſephus exiſted, than that ſuch a perſon as Ariſtobulus did not exiſt. If the writings which have paſſed under his name were a forgery of the ſecond century, it is ſurpriſing that they ſhould have impoſed upon Clemens Alexandrinus, who lived in the ſame century, and was a man of abilities, learning, and well acquainted with the writings of the ancients. Euſebius, too, in his *Præp. Evan.* quotes the Commentaries of Ariſtobulus. But, continues the learned Dean, "Clemens Alexandrinus is the firſt author that mentions them. Now, had any ſuch commentaries exiſted in the time of Philo and Joſephus, they would ſurely have mentioned them. But is the circumſtance of its not being quoted by every ſucceeding author a ſufficient reaſon to diſprove the authenticity of any book? Neither Philo nor Joſephus undertook to give a liſt of preceding authors, and it was by no means the uniform practice of theſe times always to name the authors from whom they derived their information."

4. Prideaux farther contends, that the ſum which Ptolemy is ſaid to have given to the interpreters is too great to be credible. If his computation were juſt, it certainly would be ſo. He makes it 2,000,000l. ſterling, but other writers * reduce it to 85,421l. and ſome to 56,947l.; neither of which is a ſum ſo very extraordinary in ſo great and magnificent a prince as Philadelphus, who ſpent, according to a paſſage in Athenæus (lib. v.), not leſs than 10,000 talents on the furniture of one tent; which is ſix times more than what was ſpent in the whole of the embaſſy and tranſlation, which amounted only to 1552 talents.

* Blair's Lectures on the Canon.

5. Prideaux ſays, "that what convicts the whole ſtory of Ariſteas of falſity is, that he makes Demetrius Phalereus to be the chief actor in it, and a great favourite of the king; whereas Philadelphus, as ſoon as his father was dead, caſt him into priſon, where he ſoon after died." But it may be replied, that Philadelphus reigned two years jointly with his father Lagus, and it is not ſaid by Hermippus that Demetrius was out of favour with Philadelphus during his father's life. Now, if the Septuagint was tranſlated in the beginning of the reign of Philadelphus, as Euſebius and Jerome think, the difficulty will be removed. Demetrius might have been librarian during the reign of Philadelphus, and yet impriſoned on the death of Lagus. Indeed, as the cauſe of Philadelphus's diſpleaſure was the advice which Demetrius gave to his father, to prefer the ſons of Arſinoë before the ſon of Bernice, he could ſcarcely ſhow it till his father's death. The Septuagint tranſlation might therefore be begun while Philadelphus reigned jointly with his father, but not be finiſhed till after his father's death.

Stillingfleet's Origines Sacræ.

6. Beſides the objections which have been conſidered, there is only one that deſerves notice. The ancient Chriſtians not only differ from one another concerning the time in which Ariſtobulus lived, but even contradict themſelves in different parts of their works†. Sometimes they tell us, he dedicated his book to Ptolemy Philometer, at other times they ſay, it was addreſſed to Philadelphus and his father. Sometimes they make him the ſame perſon who is mentioned in 2 Maccabees, chap 1. and ſometimes one of the 72 interpreters 152 years before. It is difficult to explain how authors fall into ſuch inconſiſtencies, but it is probably occaſioned by their quoting from memory. This was certainly the practice of almoſt all the early Chriſtian writers, and ſometimes of the apoſtles themſelves. Miſtakes were therefore inevitable. Joſephus has varied in the circumſtances of the ſame event, in his antiquities and wars of the Jews, probably from the ſame cauſe; but we do not hence conclude, that every circumſtance of ſuch a relation is entirely falſe. In the account of the Marquis of Argyle's death in the reign of Charles II. we have a very remarkable contradiction. Lord Clarendon relates, that he was condemned to be hanged, which was performed the ſame day: on the contrary, Burnet, Woodrow, Heath, Echard, concur in ſtating, that he was beheaded; and that he was condemned upon the Saturday and executed upon the Monday †. Was any reader of Engliſh hiſtory ever ſceptic enough to raiſe from hence a queſtion, whether the Marquis of Argyle was executed or not? Yet this ought to be left in uncertainty according to the way of reaſoning in which the facts reſpecting the tranſlation of the Septuagint is attempted to be diſproved.

Prideaux's Connections. vol. ii. b. i.

† Biogra. Britan.

Such are the objections which the learned and ingenious Prideaux has raiſed againſt the common account of the Septuagint tranſlation, and ſuch are the anſwers which may be given to them. We have choſen to ſupport that opinion which is ſanctioned by hiſtorical evidence, in preference to the conjectures of modern critics however ingenious; being perſuaded, that there are many things recorded in hiſtory, which, though perfectly true, yet, from our imperfect knowledge of the concomitant circumſtances, may, at a diſtant period, ſeem liable to objections. To thoſe who require poſitive evidence, it may be ſtated thus. Ariſtæas, Ariſtobulus, Philo, and Joſephus, aſſure us, that the law was tranſlated. Taking the law in the moſt reſtricted ſenſe, we have at leaſt ſufficient authority to aſſert, that the Pentateuch was rendered into Greek under Ptolemy Philadelphus. Ariſtobulus affirms, that the whole Scriptures were tranſlated by the ſeventy-two. Joſephus confines their labours to the books of Moſes. He therefore who cannot determine to which of the two the greateſt reſpect is due, may ſuſpend his opinion. It is certain, however, that many of the other books were tranſlated before the age of our Saviour; for they are quoted both by him and his apoſtles: and, perhaps, by a minute examination of ancient authors, in the ſame way that Dr Lardner has examined the Chriſtian fathers to prove the antiquity of the New Teſtament, the preciſe period in which the whole books of the Septuagint were compoſed might, with conſiderable accuracy, be aſcertained.

For 400 years this tranſlation was in high eſtimation with the Jews. It was read in their ſynagogues in preference to the Hebrew; not only in thoſe places where Greek was the common language, but in many ſynagogues of Jeruſalem and Judea. But when they ſaw that it was equally valued by the Chriſtians, they be-

Septuagint. came jealous of it, and at length, in the fecond century, Aquila, an apoftate Chriftian, attempted to fubftitute another Greek tranflation in its place. In this work he was careful to give the ancient prophecies concerning the Meffiah a different turn from the Septuagint, that they might not be applicable to Chrift. In the fame defign he was followed by Symmachus and Theodotion, who alfo, as St Jerome informs us, wrote out of hatred to Chriftianity.

In the mean time, the Septuagint, from the ignorance, boldnefs, and careleffnefs of tranfcribers, became full of errors. To correct thefe, Origen publifhed a new edition in the beginning of the third century, in which he placed the tranflations of Aquila, Symmachus, and Theodotion. This edition was called *Tetrapla*, the tranflations being arranged oppofite to one another in four columns. He alfo added one column, containing the Hebrew text in Hebrew letters, and another exhibiting it in Greek. In a fecond edition he publifhed two additional Greek verfions; one of which was found at Nicopolis, and the other at Jericho; this was called the *Hexapla*. By comparing fo many tranflations, Origen endeavoured to form a correct copy of the Scriptures. Where they all agreed, he confidered them right. The paffages which he found in the LXX, but not in the Hebrew text, he marked with an obelifk: what he found in the Hebrew, but not in the LXX, he marked with an afterifk. St Jerome fays, that the additions which Origen made to the LXX, and marked with an afterifk, were taken from Theodotion. From this valuable work of Origen the verfion of the LXX was tranfcribed in a feparate volume, with the afterifks and obelifks for the ufe of the churches; and from this circumftance the great work itfelf was neglected and loft.

About the year 300 two new editions of the LXX were publifhed; the one by Hefychius an Egyptian bifhop, and the other by Lucian a prefbyter of Antioch. But as thefe authors did not mark with any note of diftinction the alterations which they had made, their edition does not poffefs the advantages of Origen's.

The beft edition of the LXX is that of Dr Grabe, which was publifhed in the beginning of the prefent century. He had accefs to two MSS, nearly of equal antiquity, the one found in the Vatican library at Rome, the other in the royal library at St James's. which was prefented to Charles I. by Cyril, patriarch of Alexandria, and hence is commonly called the *Alexandrian MS.* Anxious to difcover which of thefe was according to the edition of Origen, Dr Grabe collected the fragments of the Hexapla, and found they agreed with the Alexandrian MS. but not with the Vatican where it differed with the other. Hence he concluded that the Alexandrian MS. was taken from the edition of Origen. By comparing the quotations from fcripture in the works of Athanafius and St Cyril (who were patriarchs of Alexandria at the time St Jerome fays Hefychius's edition of the LXX was there ufed) with the Vatican MS. he found they agreed fo well that he juftly inferred that that MS. was taken from the edition of Hefychius.

This verfion was in ufe to the time of our bleffed Saviour, and is that out of which moft of the citations in the New Teftament, from the Old, are taken. It was alfo the ordinary and canonical tranflation made ufe of by the Chriftian church in the earlieft ages; and it ftill fubfifts in the churches both of the eaft and weft. Septuagint ‖ Sepulchre.

Thofe who defire a more particular account of the Septuagint tranflations may confult Hody *de Bibliorum Textibus*, Prideaux's Connections, Owen's Inquiry into the Septuagint Verfion, Blair's Lectures on the Canon, and Michaelis's Introduction to the New Teftament, laft edition.

SEPTUAGINT Chronology, the chronology which is formed from the dates and periods of time mentioned in the Septuagint tranflation of the Old Teftament. It reckons 1500 years more from the creation to Abraham than the Hebrew bible. Dr Kennicot, in the differtation prefixed to his Hebrew bible, has fhown it to be very probable that the chronology of the Hebrew fcriptures, fince the period juft mentioned, was corrupted by the Jews, between the years 175 and 200, and that the chronology of the Septuagint is more agreeable to truth. It is a fact, that during the fecond and third centuries the Hebrew fcriptures were almoft entirely in the hands of the Jews, while the Septuagint was confined to the Chriftians. The Jews had therefore a very favourable opportunity for this corruption. The following is the reafon which is given by oriental writers: It being a very ancient tradition, that the Meffiah was to come in the fixth chiliad, becaufe he was to come in the laft days (founded on a myftical application of the fix days creation), the contrivance was *to fhorten the age of the world from about* 5500 *to* 3760; *and thence to prove that Jefus could not be the Meffiah.* Dr Kennicot adds, that fome Hebrew copies having the larger chronology were extant till the time of Eufebius, and fome till the year 700.

SEPTUM, in *Anatomy*, an inclofure or partition; a term applied to feveral parts of the body, which ferve to feparate one part from another; as, *feptum narium*, or partition between the noftrils, &c.

SEPULCHRAL, fomething belonging to fepulchres or tombs: thus a fepulchral column is a column erected over a tomb, with an infcription on its fhaft; and fepulchral lamps, thofe faid to have been found burning in the tombs of feveral martyrs and others. See LAMP.

SEPULCHRE, a tomb or place deftined for the interment of the dead. This term is chiefly ufed in fpeaking of the burying-places of the ancients, thofe of the moderns being ufually called *tombs*.

Sepulchres were held facred and inviolable; and the care taken of them has always been held a religious duty, grounded on the fear of God, and the belief of the foul's immortality. Thofe who have fearched or violated them have been thought odious by all nations, and were always feverely punifhed.

The Egyptians called fepulchres *eternal houfes*, in contradiftinction to their ordinary houfes or palaces, which they called *inns*, on account of their fhort ftay in the one in comparifon of their long abode in the other. See TOMB.

Regular Canons of St SEPULCHRE, a religious order, formerly inftituted at Jerufalem, in honour of the holy fepulchre, or the tomb of Jefus Chrift.

Many of thefe canons were brought from the Holy Land into Europe, particularly into France, by Louis the Younger; into Poland, by Jaxa, a Polifh gentleman; and into Flanders, by the counts thereof; many alfo also came into England. This order was, however, suppressed by Pope Innocent VIII. who gave its revenues and effects to that of our Lady of Bethlehem: which also becoming extinct, they were bestowed on the knights of St John of Jerusalem. But the suppression did not take effect in Poland, where they still subsist, as also in several provinces of Germany. These canons follow the rule of St Augustine.

Knights of the Holy SEPULCHRE, a military order, established in Palestine about the year 1114.

The knights of this order in Flanders chose Philip II. king of Spain, for their master, in 1558, and afterwards his son; but the grand-master of the order of Malta prevailed on the last to resign; and when afterwards the duke of Nevers assumed the same quality in France, the same grand-master, by his interest and credit, procured a like renunciation of him, and a confirmation of the union of this order to that of Malta.

SEQUANI, a people anciently forming a part of Gallia Celtica, but annexed to Belgica by Augustus, separated from the Helvetii by Mount Jura, with the Rhine on the east (Strabo), bordering on the Ædui and Segustiano to the south, and Lingones to the west (Tacitus). Now Franche Comte.

SEQUESTRATION, in *Common Law*, is setting aside the thing in controversy from the possession of both the parties that contend for it. In which sense it is either voluntary, as when done by the consent of the parties; or necessary, as where it is done by the judge, of his own authority, whether the parties will or not.

SEQUESTRATION, in the *Civil Law*, is the act of the ordinary, disposing of the goods and chattels of one deceased, whose estate no man will meddle with.

A widow is also said to sequester, when she disclaims having any thing to do with the estate of her deceased husband.

Among the Romanists, in questions of marriage, where the wife complains of impotency in the husband, she is to be sequestered into a convent, or into the hands of matrons, till the process be determined.

SEQUESTRATION is also used for the act of gathering the fruits of a benefice void, to the use of the next incumbent.

Sometimes a benefice is kept under sequestration for many years, when it is of so small value, that no clergyman fit to serve the cure will be at the charge of taking it by institution; in which case the sequestration is committed either to the curate alone, or to the curate and church-wardens jointly. Sometimes the profits of a living in controversy, either by the consent of the parties, or the judge's authority, are sequestered and placed for safety in a third hand, till the suit is determined, a minister being appointed by the judge to serve the cure, and allowed a certain salary out of the profits. Sometimes the profits of a living are sequestered for neglect of duty, for dilapidations, or for satisfying the debts of the incumbent.

SEQUESTRATION, in chancery, is a commission usually directed to seven persons therein named, empowering them to seize the defendant's personal estate, and the profits of his real, and to detain them, subject to the order of the court. It issues on the return of the serjeant at arms, wherein it is certified, that the defendant had secreted himself.

Sequestrations were first introduced by Sir Nicholas Bacon, lord keeper in the reign of Queen Elizabeth; before which the court found some difficulty in enforcing its process and decrees; and they do not seem to be in the nature of process to bring in the defendant, but only intended to enforce the performance of the court's decree.

A sequestration is also made, in London, upon an action of debt; the course of proceeding in which case is this: The action being entered, the officer goes to the defendant's shop or warehouse, when no person is there, and takes a padlock, and hangs it on the door, uttering these words: "I do sequester this warehouse, and the goods and merchandise therein, of the defendant in this action, to the use of the plaintiff," &c. after which he sets on his seal, and makes a return of the sequestration in the compter; and four days being passed after the return made, the plaintiff may. at the next court, have judgment to open the shop or warehouse, and to have the goods appraised by two freemen, who are to be sworn at the next court held for that compter; and then the serjeant puts his hand to the bill of appraisement, and the court grants judgment thereon; but yet the defendant may put in bail before satisfaction, and by that means dissolve the sequestration; and after satisfaction, may put in bail to disprove the debt, &c.

In the time of the civil wars, sequestration was used for a seizing of the estates of delinquents for the use of the commonwealth.

SEQUESTRATION, in *Scots Law*. See LAW *Index*.

SEQUIN, a gold coin, struck at Venice, and in several parts of the Grand Signior's dominions. In Turkey, it is called *dahob*, or piece of gold, and according to Volney is in value about 6s. 3d. sterling. It varies, however, considerably in its value in different countries. At Venice it is equal to about 9s. 2d. sterling.

The Venetian sequins are in great request in Syria, from the fineness of their standard, and the practice they have of employing them for women's trinkets. The fashion of these trinkets does not require much art; the piece of gold is simply pierced, in order to suspend it by a chain, likewise of gold, which flows upon the breast. The more sequins that are attached to this chain, and the greater the number of these chains, the more is a woman thought to be ornamented. This is the favourite luxury, and the emulation of all ranks. Even the female peasants, for want of gold, wear piastres or smaller pieces; but the women of a certain rank disdain silver; they will accept of nothing but sequins of Venice, or large Spanish pieces, and crusadoes. Some of them wear 260 or 300, as well lying flat, as strung one on another, and hung near the forehead, at the edge of the head dress. It is a real load: but they do not think they can pay too dearly for the satisfaction of exhibiting this treasure at the public bath, before a crowd of rivals, to awaken whose jealousy constitutes their chief pleasure. The effect of this luxury on commerce, is the withdrawing considerable sums from circulation, which remain dead; besides, that when any of these pieces return into common use, having lost their

Seraglio. their weight by being pierced, it becomes neceſſary to weigh them. The practice of weighing money is general in Syria, Egypt, and all Turkey. No piece, however effaced, is refuſed there; the merchant draws out his ſcales and weighs it, as in the days of Abraham, when he purchaſed his ſepulchre. In conſiderable payments, an agent of exchange is ſent for, who counts paras by thouſands, rejects a great many pieces of falſe money, and weighs all the ſequins, either ſeparately or together.

SERAGLIO, formed from the Perſian word *ſeraw*, or Turkiſh word *ſarai*, which ſignifies a houſe, and is commonly uſed to expreſs the houſe or palace of a prince. In this ſenſe it is frequently uſed at Conſtantinople; the houſes of foreign ambaſſadors are called *ſeraglios*. But it is commonly uſed by way of eminence for the palace of the grand ſignior at Conſtantinople, where he keeps his court, and where his concubines are lodged, and where the youth are trained up for the chief poſts of the empire.

It is a triangle about three Italian miles round, wholly within the city, at the end of the promontory Chryſoceras, now called the *Seraglio Point*. The buildings run back to the top of the hill, and from thence are gardens that reach to the edge of the ſea. It is incloſed with a very high and ſtrong wall, upon which there are ſeveral watch towers: and it has many gates, ſome of which open towards the ſea ſide, and the reſt into the city; but the chief gate is one of the latter, which is conſtantly guarded by a company of capoochees, or porters; and in the night it is well guarded towards the ſea. The outward appearance is not very beautiful, the architecture being irregular, conſiſting of ſeparate edifices in the form of pavilions and domes.

The ladies of the ſeraglio are a collection of beautiful young women, chiefly ſent as preſents from the provinces and the Greek iſlands, moſt of them the children of Chriſtian parents. The brave prince Heraclius hath for ſome years paſt aboliſhed the infamous tribute of children of both ſexes, which Georgia formerly paid every year to the Porte. The number of women in the harem depends on the taſte of the reigning monarch or ſultan. Selim had 2000, Achmet had but 300, and his ſucceſſor had nearly 1600. On their admiſſion they are committed to the care of old ladies, taught ſewing and embroidery, muſic, dancing, and other accompliſhments, and furniſhed with the richeſt clothes and ornaments. They all ſleep in ſeparate beds, and between every fifth there is a preceptreſs. Their chief governeſs is called *Katon Kiaga*, or governeſs of the noble young ladies. There is not one ſervant among them, for they are obliged to wait on one another by rotation; the laſt that is entered ſerves her who preceded her and herſelf. Theſe ladies are ſcarcely ever ſuffered to go abroad, except when the grand ſignior removes from one place to another, when a troop of black eunuchs conveys them to the boats, which are incloſed with lattices and linen curtains; and when they go by land they are put into cloſe chariots, and ſignals are made at certain diſtances, to give notice that none approach the roads through which they march. The boats of the harem, which carry the grand ſignior's wives, are manned with 24 rowers, and have white covered tilts, ſhut alternately by Venetian blinds. Among the emperor's attendants are a number of mutes, who act and converſe by ſigns with great quickneſs, and ſome dwarfs, who are exhibited for the diverſion of his Majeſty. Seraglio.

When he permits the women to walk in the gardens of the ſeraglio, all people are ordered to retire, and on every ſide there is a guard of black eunuchs, with ſabres in their hands, while others go their rounds in order to hinder any perſon from ſeeing them. If, unfortunately, any one is found in the garden, even through ignorance or inadvertence, he is undoubtedly killed, and his head brought to the feet of the grand ſignior, who gives a great reward to the guard for their vigilance. Sometimes the grand ſignior paſſes into the gardens to amuſe himſelf when the women are there; and it is then that they make uſe of their utmoſt efforts, by dancing, ſinging, ſeducing geſtures, and amorous blandiſhments, to enſnare the affections of the monarch. It is not permitted that the monarch ſhould take a virgin to his bed, except during the ſolemn feſtivals, and on occaſion of ſome extraordinary rejoicings, or the arrival of ſome good news. Upon ſuch occaſions, if the ſultan chooſe a new companion to his bed, he enters into the apartment of the women, who are ranged in files by the governeſſes, to whom he ſpeaks, and intimates the perſon he likes beſt: the ceremony of the handkerchief, which the grand ſignior is ſaid to throw to the girl that he elects, is an idle tale, without any foundation. As ſoon as the grand ſignior has choſen the girl that he has deſtined to be the partner of his bed, all the others follow her to the bath, waſhing and perfuming her, and dreſſing her ſuperbly, conducting her ſinging, dancing, and rejoicing, to the bed chamber of the grand ſignior, who is generally, on ſuch an occaſion, already in bed. Scarcely has the new-elected favourite entered the chamber, introduced by the grand eunuch who is upon guard, than ſhe kneels down, and when the ſultan calls her, ſhe creeps into bed to him by the foot of the bed, if the ſultan does not order her, by eſpecial grace, to approach by the ſide: after a certain time, upon a ſignal given by the ſultan, the governeſs of the girls, with all her ſuite, enters the apartment, and takes her back again, conducting her with the ſame ceremony to the women's apartments; and if by good fortune ſhe becomes pregnant, and is delivered of a boy, ſhe is called *aſaki ſultaneſs*, that is to ſay, ſultaneſs-mother; for the firſt ſon ſhe has the honour to be crowned, and ſhe has the liberty of forming her court. Eunuchs are alſo aſſigned for her guard, and for her particular ſervice. No other ladies, though delivered of boys, are either crowned or maintained with ſuch coſtly diſtinction as the firſt; however, they have their ſervice apart, and handſome appointments. After the death of the ſultan, the mothers of the male children are ſhut up in the old ſeraglio, from whence they can never come out any more, unleſs any of their ſons aſcend the throne. Baron de Tott informs us, that the female ſlave who becomes the mother of a ſultan, and lives long enough to ſee her ſon mount the throne, is the only woman who at that period alone acquires the diſtinction of *ſultana-mother*; ſhe is till then in the interior of her priſon with her ſon. The title of *bache kadun*, principal woman, is the firſt dignity of the grand ſignior's harem; and ſhe has a larger allowance

Seraglio. allowance than thoſe who have the title of ſecond, third, and fourth woman, which are the four free women the Koran allows.

This is a deſcription of the grand ſignior's ſeraglio: we ſhall now add an account of the ſeraglio or *harem*, as it is often called, of the emperor of Morocco, from the very intereſting tour of Mr Lempriere. This gentleman being a ſurgeon by profeſſion, was admitted into the harem to preſcribe for ſome of the ladies who were indiſpoſed, and was therefore enabled to give a particular account of this female priſon, and, what is ſtill more curious, of the manners and behaviour of its inhabitants.

The harem forms a part of the palace. The apartments, which are all on the ground floor, are ſquare, very lofty, and four of them incloſe a ſpacious ſquare court, into which they open by means of large folding doors. In the centre of theſe courts, which are floored with blue and white chequered tiling, is a fountain, ſupplied by pipes from a large reſervoir on the outſide of the palace, which ſerves for the frequent ablutions recommended by the Mahometan religion, as well as for other purpoſes. The whole of the harem conſiſts of about twelve of theſe ſquare courts, communicating with each other by narrow paſſages, which afford a free acceſs from one part of it to another, and of which all the women are allowed to avail themſelves.

The apartments are ornamented on the outſide with beautiful carved wood. In the inſide moſt of the rooms are hung with rich damaſk of various colours; the floors are covered with beautiful carpets, and there are matreſſes diſpoſed at different diſtances, for the purpoſes of ſitting and ſleeping.

Beſides theſe, the apartments are furniſhed at each extremity with an elegant European mahogany bedſtead, hung with damaſk, having on it ſeveral mattreſſes placed one over the other, which are covered with various coloured ſilks; but theſe beds are merely placed there to ornament the room. In all the apartments, without exception, the ceiling is wood, carved and painted. The principal ornaments in ſome were large and valuable looking-glaſſes, hung on different parts of the walls. In others, clocks and watches of different ſizes, in glaſs caſes, were diſpoſed in the ſame manner.

The ſultana Lalla Batoom and another favourite were indulged with a whole ſquare to themſelves; but the concubines were only each allowed a ſingle room.

Each female had a ſeparate daily allowance from the emperor, proportioned to the eſtimation in which they were held by him. The late emperor's allowance was very trifling: Lalla Douyaw, the favourite ſultana, had very little more than half-a-crown Engliſh a-day, and the others leſs in proportion. It muſt be allowed, that the emperor made them occaſional preſents of money, dreſs, and trinkets; but this could never be ſufficient to ſupport the number of domeſtics and other expences they muſt incur. Their greateſt dependence therefore was on the preſents they received from thoſe Europeans and Moors who viſited the court, and who employed their influence in obtaining ſome particular favour from the emperor. This was the moſt ſucceſsful mode that could be adopted. When Mr Lempriere was at Morocco, a Jew, deſirous of obtaining a very advantageous favour from the emperor, for which he had been a long time unſucceſsfully ſoliciting, ſent to all the principal ladies of the harem preſents of pearls to a very large amount; the conſequence was, that they all went in a body to the emperor, and immediately obtained the wiſhed-for conceſſion. Seraglio.

The ladies ſeparately furniſh their own rooms, hire their own domeſtics, and, in fact, do what they pleaſe in the harem, but are not permitted to go out without an expreſs order from the emperor, who very ſeldom grants them that favour, except when they are to be removed from one palace to another. In that caſe, a party of ſoldiers is diſpatched a little diſtance before them, to diſperſe the male paſſengers in particular, and to prevent the poſſibility of their being ſeen. This previous ſtep being taken, a piece of linen cloth is tied round the lower part of the face, and afterwards theſe miſerable females cover themſelves entirely with their haicks, and either mount mules, which they ride like men, or, what is more uſual, are put into a ſquare carriage or litter, conſtructed for this purpoſe, which by its lattice-work allows them to ſee without being ſeen. In this manner they ſet off, under the charge of a guard of black eunuchs. This journey, and ſometimes a walk within the bounds of the palace, with which they are, however, ſeldom indulged, is the only exerciſe they are permitted to take.

The late emperor's harem conſiſted of between 60 and 100 females, beſides their domeſtics and ſlaves, which were very numerous. Many of the concubines were Mooriſh women, who had been preſented to the emperor, as the Moors conſider it an honour to have their daughters in the harem; ſeveral were European ſlaves, who had either been made captives, or purchaſed by the emperor; and ſome were Negroes.

In this group the Europeans, or their deſcendants, had by far the greateſt claim to the character of handſome. There was one in particular, who was a native of Spain, and taken into the harem at about the ſame age as Lalla Douyaw, who was indeed a perfect beauty. Nor was this lady quite ſingular in that reſpect, for many others were almoſt equally handſome.

The eunuchs, who have the entire charge of the women, and who in fact live always among them, are the children of Negro ſlaves. They are generally either very ſhort and fat, or elſe tall, deformed, and lame. Their voices have that particular tone which is obſervable in youths who are juſt arriving at manhood; and their perſons altogether afford a diſguſting image of weakneſs and effeminacy.

The ſame gentleman gives us a very curious account of the manners and ignorance of theſe immured females, from his own obſervation, when viſiting the prince's harem. "Attended by an eunuch (ſays he), after paſſing the gate of the harem, which is always locked, and under the care of a guard of eunuchs, we entered a narrow and dark paſſage, which ſoon brought us to the court, into which the women's chambers open. We here ſaw numbers of both black and white women and children; ſome concubines, ſome ſlaves, and others hired domeſtics.

"Upon their obſerving the unuſual figure of an European, the whole multitude in a body ſurrounded me, and expreſſed the utmoſt aſtoniſhment at my dreſs and appearance. Some ſtood motionleſs, with their hands lifted up, their eyes fixed, and their mouths open, in the

Seraglio.

the uſual attitude of wonder and ſurpriſe. Some burſt into immoderate fits of laughter; while others again came up, and with uncommon attention eyed me from head to foot. The parts of my dreſs which ſeemed moſt to attract their notice were my buckles, buttons, and ſtockings; for neither men nor women in this country wear any thing of the kind. With reſpect to the club of my hair, they ſeemed utterly at a loſs in what view to conſider it; but the powder which I wore they conceived to be employed for the purpoſe of deſtroying vermin. Moſt of the children, when they ſaw me, ran away in the moſt perfect conſternation; and on the whole, I appeared as ſingular an animal, and I dare ſay had the honour of exciting as much curioſity and attention, as a lion or man-tiger juſt imported from abroad, and introduced into a country town in England on a market-day. Every time I viſited the harem, I was ſurrounded and laughed at by this curious mob, who, on my entering the gate, followed me cloſe to the very chamber to which I was proceeding, and on my return univerſally eſcorted me out.

"The greateſt part of the women were uncommonly fat and unwieldy; had black and full eyes, round faces, with ſmall noſes. They were of different complexions; ſome very fair, ſome ſallow, and others again perfect Negroes.

"One of my new patients being ready to receive me, I was deſired to walk into her room; where, to my great ſurpriſe, I ſaw nothing but a curtain drawn quite acroſs the apartment, ſimilar to that of a theatre which ſeparates the ſtage from the audience. A female domeſtic brought a very low ſtool, placed it near the curtain, and told me I was to ſit down there, and feel her miſtreſs's pulſe.

"The lady, who had by this time ſummoned up courage to ſpeak, introduced her hand from the bottom of the curtain, and deſired me to inform her of all her complaints, which ſhe conceived I might perfectly do by merely feeling the pulſe. It was in vain to aſk her where her pain was ſeated, whether in her ſtomach, head, or back; the only anſwer I could procure was a requeſt to feel the pulſe of the other hand, and then point out the ſeat of the diſeaſe, and the nature of the pain.

"Having neither ſatisfied my curioſity by exhibiting her face, nor made me acquainted with the nature of her complaint, I was under the neceſſity of informing her in poſitive terms, that to underſtand the diſeaſe it was abſolutely neceſſary to ſee the tongue as well as to feel the pulſe; and that without it I could do nothing for her. My eloquence, or rather that of my Jewiſh interpreter, was, however, for a long time exerted in vain; and I am perſuaded ſhe would have diſmiſſed me without any further inquiry, had not her invention ſupplied her with a happy expedient to remove her embarraſſment. She contrived at laſt to cut a hole through the curtain, through which ſhe extruded her tongue, and thus complied with my injunction as far as it was neceſſary in a medical view, but moſt effectually diſappointed my curioſity.

"I was afterwards ordered to look at another of the prince's wives, who was affected with a ſcrophulous ſwelling in her neck. This lady was, in the ſame manner as the other, at firſt excluded from my ſight; but as ſhe was obliged to ſhow me her complaint, I had an opportunity of ſeeing her face, and obſerved it to be very handſome."

Seraglio || Serapis.

It is curious to obſerve the ſtrange and childiſh notions of perſons who have been wholly ſecluded from the world. All the ladies of the harem expected that our author ſhould have inſtantly diſcovered their complaints upon feeling the pulſe, and that he could cure every diſeaſe inſtantaneouſly. He found them proud and vain of their perſons, and extremely ignorant. "Among many ridiculous queſtions, they aſked my interpreter (ſays Mr Lempriere) if I could read and write; upon being anſwered in the affirmative, they expreſſed the utmoſt ſurpriſe and admiration at the abilities of the Chriſtians. There was not one among them who could do either; theſe rudiments of learning are indeed only the lot of a few of their men, who on that account are named *Talbs*, or explainers of the Mahometan law."

It is melancholy to reflect on the ſituation of theſe unfortunate women. Being conſidered as the mere inſtruments of pleaſure, no attention is paid to the improvement of their minds. They have no employment to occupy their time. Their needle-work is performed by Jeweſſes; their food is dreſſed, and their chambers taken care of, by ſlaves and domeſtics. They have no amuſement but a rude and barbarous kind of melancholy muſic, without melody, variety, or taſte; and converſation with one another, which muſt indeed be very confined, uniform, and inanimate, as they never ſee a new object. Excluded from the enjoyment of freſh air and exerciſe, ſo neceſſary for the ſupport of health and life; deprived of all ſociety but that of their fellow ſufferers, a ſociety to which moſt of them would prefer ſolitude itſelf; they are only to be conſidered as the moſt abject of ſlaves—ſlaves to the vices and caprice of a licentious tyrant, who exacts even from his wives themſelves a degree of ſubmiſſion and reſpect which borders upon idolatry, and which God and nature never meant ſhould be paid to a mortal.

SERAI, a building on the high-road, or in large cities in India, erected for the accommodation of travellers.

SERAPH, or SERAPHIM, ſpirits of the higheſt rank in the hierarchy of angels; who are thus called from their being ſuppoſed to be moſt inflamed with divine love, by their nearer and more immediate attendance at the throne of God, and to communicate their fervour to the remoter and inferior orders. Seraphim is the Hebrew plural of ſeraph. See ANGEL.

SERAPHIC, burning or inflamed with love or zeal, like a ſeraphim: thus St Bonaventure is called the *ſeraphic doctor*, from his abundant zeal and fervour.

SERAPIAS, a genus of plants belonging to the claſs of gynandria; and in the natural ſyſtem arranged under the ſeventh order *Orchideæ*. See BOTANY *Index*.

SERAPION, a phyſician of Alexandria. He and Philinus of the iſle of Cos were both ſcholars of Herophilus, and were founders of the empiric ſect; which happened about 287 B. C.

SERAPIS, in *Mythology*, an Egyptian deity, who was worſhipped under various names and attributes, as, the tutelary god of Egypt in general, and as the patron of ſeveral of their principal cities. Tacitus informs us, that he was worſhipped as a kind of univerſal deity that repreſented Eſculapius, Oſiris, Jupiter, and Pluto; and he he was sometimes taken for Jupiter Ammon, the Sun, and Neptune: and the honours that were rendered to him at Alexandria were more solemn and extraordinary than those of any other place.

Plutarch and Clemens of Alexandria, as well as Tacitus *, inform us, that while the first Ptolemy was employed in fortifying Alexandria with walls, adorning it with temples and stately buildings, there appeared to him in his sleep a young man of extraordinary beauty, of a stature more than human, admonishing him to dispatch into Pontus some of his most trusty friends to bring from thence his statue: he assured him, that the city and kingdom which possessed it should prove happy, glorious, and powerful. The young man having thus spoken, disappeared, mounting up into heaven in a blaze of fire.

* Tac. Hist. lib. iv. cap. 3. Plut. de Iside et Osiride. Clem. Alex in Protrep.

Ptolemy discovered his vision to the priests; but finding them ignorant of Pontus, he had recourse to an Athenian, who informed him that near Sinope, a city of Pontus, there was a temple much resorted to by the natives, which was consecrated to Pluto, where he had a statue, near which stood that of a woman. Ptolemy, neglecting the injunctions of the apparition, it again appeared to him in a menacing attitude; and the king immediately dispatched ambassadors to the Serapian monarch, loaded with presents. The king of Sinope consented; but his subjects opposed the removal of the statue. The god, however, of his own accord, as we are informed, conveyed himself to the ambassador's ship, and in three days landed in Alexandria. The statue of Serapis was erected in one of the suburbs of the city, where a magnificent temple was afterwards reared.

The statue of Serapis, according to Macrobius, was of a human form, with a basket or bushel on his head, signifying plenty; his right hand leaned on the head of a serpent, whose body was wound round a figure with three heads, of a dog, a lion, and a wolf; in his left hand he held a measure of a cubit length, as it were to take the height of the waters of the Nile. The figure of Serapis is found on many ancient medals.

The famous temple of Serapis at Alexandria was destroyed by order of Theodosius; and the celebrated statue of this deity was broken in pieces, and its limbs carried first in triumph by the Christians through the city, and then thrown into a fierce fire, kindled for that purpose in the amphitheatre. As the Egyptians ascribed the overflowing of the Nile, to which was owing the fertility of their country, to the benign influence of their god Serapis, they concluded, that now he was destroyed, the river would no longer overflow, and that a general famine would ensue; but when they observed, on the contrary, that the Nile swelled to a greater height than had been known in the memory of man, and thereby produced an immense plenty of all kinds of provisions, many of the pagans renouncing the worship of idols, adored the God of the Christians.

SERENA GUTTA, the same as *amaurosis*. See MEDICINE, N° 360.

SERENADE, a kind of concert given in the night by a lover to his mistress, under her window. These sometimes only consist of instrumental music, but at other times voices are added: the music and songs composed for these occasions are also called *serenades*.

SERENE, a title of honour given to several princes and to the principal magistrates of republics. The king of Britain, the republic and doge of Venice, and the children of the king of Spain, are called *most serene*; and when the pope or the sacred college write to the emperor, to kings, or to the doge, they give them no other title. In like manner, the emperor gives no other title to any king, except to the king of France.

SERENUS, SAMMONICUS, a celebrated physician in the reigns of the emperors Severus and Caracalla, in and about the year 200. He wrote several treatises on history and the works of nature; but there is only one of them extant, which is a very indifferent poem on the Remedies of Diseases. He was murdered at a festival by the order of Caracalla. He had a library that contained 62,000 volumes, which Quintus Serenus Sammonicus his son gave to Gordian the Younger, to whom he was preceptor.

SERES (Ptolemy); a people of the Farther Asia; bounded on the west by Scythia extra Imaum; on the north and east, by Terra Incognita; and on the south, by India extra Gangem. According to these limits, their country answers nearly to Cathoy or North China. Other authors vary greatly in placing them, though the generality agree in placing them far to the east. Mela places them between the Indi and Scythæ; and perhaps beyond the Indi, if we distinguish the Sinæ from them. The ancients commend them for their cotton manufactures, different from the produce of the bombyces or silk-worms, called *seres* by the Greeks; whence *serica*, "silk."

SERGE, a woollen quilted stuff, manufactured on a loom with four treddles, after the manner of rateens, and other stuffs that have the whale. The goodness of serges is known by the quilting, as that of cloths by the spinning. Of serges there are various kinds, denominated either from the different qualities thereof, or from the places where they are wrought. The most considerable is the London serge, now highly valued abroad, particularly in France, where a manufacture is carried on with considerable success, under the title of *serge façon de Londres*.

The method of making the London serge we shall now describe: For wool, the longest is chosen for the warp, and the shortest for the woof. Before either kind is used, it is first scoured, by putting it in a copper of liquor, somewhat more than lukewarm, composed of three parts of fair water and one of urine. After having stayed long enough therein for the liquor to dissolve, and take off the grease, &c. it is stirred briskly about with a wooden peel; taken out of the liquor, drained, and washed in a running water, dried in the shade, beaten with sticks on a wooden rack to drive out the coarser dust and filth, and then picked clean with the hands. Thus far prepared, it is greased with oil of olives, and the longest part, destined for the warp, is combed with large combs, heated in a little furnace for the purpose. To clear off the oil again, the wool is put in a liquor composed of hot water, with soap melted therein: whence being taken out, wrung, and dried, it is spun on the wheel.

As to the shorter wool, intended for the woof, it is only carded on the knee with small cards, and then spun on the wheel, without being scoured of its oil. It must be remarked, that the thread for the warp is always to be spun much finer, and better twisted than that of the woof. The wool both for the warp and

Serge, Sergeant. the woof being ſpun, and the thread divided into ſkains, that of the woof is put on ſpools (unleſs it have been ſpun upon them) fit for the cavity or eye of the ſhuttle; and that for the warp is wound on a kind of wooden bobbins to fit it for warping. When warped, it is ſtiffened with a kind of ſize, whereof that made of the ſhreds of parchment is held the beſt; and when dry is put on the loom.

When mounted on the loom, the workman raiſing and lowering the threads (which are paſſed through a reed), by means of four treddles placed underneath the loom, which he makes to act tranſverſely, equally, and alternately, one after another, with his feet, in proportion as the threads are raiſed and lowered, throws the ſhuttle acroſs from one ſide to the other; and each time that the ſhuttle is thrown, and the thread of the woof is croſſed between thoſe of the warp, ſtrikes it with the frame to which the reed is faſtened, through thoſe teeth the threads of the warp paſs; and this ſtroke he repeats twice or thrice, or even more, till he judges the croſſing of the ſerge ſufficiently cloſe: thus he proceeds till the warp is all filled with woof.

The ſerge now taken off the loom is carried to the fuller, who ſcours it in the trough of his mill with a kind of fat earth, called *fuller's earth*, firſt purged of all ſtones and filth. After three or four hours ſcouring, the fuller's earth is waſhed out in fair water, brought by little and little into the trough, out of which it is taken when all the earth is cleared; then, with a kind of iron pincers or plyers, they pull off all the knots, ends, ſtraws, &c. ſticking out on the ſurface on either ſide; and then returning it into the fulling trough, where it is worked with water ſomewhat more than lukewarm, with ſoap diſſolved therein for near two hours: it is then waſhed out till ſuch time as the water becomes quite clear, and there be no ſigns of ſoap left; then it is taken out of the trough, the knots, &c. again pulled off, and then put on the tenter to dry, taking care as faſt as it dries to ſtretch it out both in length and breadth till it be brought to its juſt dimenſions. When well dried, it is taken off the tenter, and dyed, ſhorn, and preſſed.

SERGEANT, or SERJEANT *at Law*, or *of the Coif*, is the higheſt degree taken at the common law, as that of Doctor is of the civil law; and as theſe are ſuppoſed to be the moſt learned and experienced in the practice of the courts, there is one court appointed for them to plead in by themſelves, which is the common pleas, where the common law of England is moſt ſtrictly obſerved: but they are not reſtricted from pleading in any other court, where the judges, who cannot have that honour till they have taken the degree of ſerjeant at law, call them *brothers*.

SERGEANT at Arms, or *Mace*, an officer appointed to attend the perſon of the king; to arreſt traitors, and ſuch perſons of quality as offend; and to attend the lord high ſteward, when ſitting in judgement on a traitor.

Of theſe, by ſtatute 13 Richard II. cap. 6. there are not to be above 30 in the realm. There are now nine at court at 100l. per annum ſalary each; they are called the *king's ſergeants at arms*, to diſtinguiſh them from others: they are created with great ceremony, the perſon kneeling before the king, his majeſty lays the mace on his right ſhoulder, and ſays, *Riſe up, ſergeant at arms, and eſquire for ever*. They have, beſides, a patent for the office, which they hold for life.

Sergeant ‖ Series. They have their attendance in the preſence-chamber, where the band of gentlemen-penſioners wait, and, receiving the king at the door, they carry the maces before him to the chapel door, whilſt the band of penſioners ſtand foremoſt, and make a lane for the king, as they alſo do when the king goes to the houſe of lords.

There are four other ſergeants at arms, created in the ſame manner; one, who attends the lord chancellor; a ſecond, the lord treaſurer; a third, the ſpeaker of the houſe of commons; and a fourth, the lord mayor of London on ſolemn occaſions.

They have a conſiderable ſhare of the fees of honour, and travelling charges allowed them when in waiting, viz. five ſhillings per day when the court is within ten miles of London, and ten ſhillings when twenty miles from London. The places are in the lord chamberlain's gift.

There are alſo ſergeants of the mace of an inferior kind, who attend the mayor or other head officer of a corporation.

Common SERGEANT, an officer in the city of London, who attends the lord mayor and court of aldermen on court days, and is in council with them on all occaſions, within and without the precincts or liberties of the city. He is to take care of orphans eſtates, either by taking account of them, or to ſign their indentures, before their paſſing the lord mayor and court of aldermen: and he was likewiſe to let and manage the orphan eſtates, according to his judgement to their beſt advantage. See RECORDER.

SERGEANT, in *War*, is an uncommiſſioned officer in a company of foot or troop of dragoons, armed with an halbert, and appointed to ſee diſcipline obſerved, to teach the ſoldiers the exerciſe of their arms, to order, ſtraiten, and form their ranks, files, &c. He receives the orders from the adjutant, which he communicates to his officers. Each company generally has two ſergeants.

SERGEANTY (*Serjeantia*), ſignifies, in law, a ſervice that cannot be due by a tenant to any lord but the king; and this is either *grand ſergeanty*, or *petit*. The firſt is a tenure by which the one holds his lands of the king by ſuch ſervices as he ought to do in perſon to the king at his coronation; and may alſo concern matters military, or ſervices of honour in peace; as to be the king's butler, carver, &c. *Petit ſergeanty* is where a man holds lands of the king to furniſh him yearly with ſome ſmall thing towards his wars; and in effect payable as rent. Though all tenures are turned into *ſoccage* by the 12 Car. II. cap. 24. yet the honorary ſervices of grand ſergeanty ſtill remain, being therein excepted. See *KNIGHT-Service*.

SERIES, in general, denotes a continual ſucceſſion of things in the ſame order, and having the ſame relation or connection with each other: in this ſenſe we ſay, a ſeries of emperors, kings, biſhops, &c.

In natural hiſtory, a ſeries is uſed for an order or ſubdiviſion of ſome claſs of natural bodies; comprehending all ſuch as are diſtinguiſhed from the other bodies of that claſs, by certain characters which they poſſeſs in common, and which the reſt of the bodies of that claſs have not.

(1.) SERIES, in *Arithmetic* or *Algebra*, a rank or progreffion of quantities which fucceed one another according to fome determinate law. For example, the numbers

$$3, 5, 7, 9, 11, 13, 15, \&c.$$

conftitute a feries, the law of which is that each term exceeds that before it by a given number, viz. 2. Again, the numbers

$$3, 6, 12, 24, 48, 96, 192, \&c.$$

conftitute a feries of a different kind, each term being the product of the term before it, and the given number 2.

(2.) As the law according to which the terms of a feries are formed may be infinitely varied, there may be innumerable kinds of feries; we fhall enumerate a few of the moft common.

1. *Arithmetical Series.* The general form of a feries of this kind is

$$a, a+d, a+2d, a+3d, a+4d, \&c.$$

and its law is that the difference between any two adjacent terms is the fame quantity, viz. d. The firft of the two preceding examples is a feries of this nature.

2. *Geometrical Series.* Its general form is

$$a, ar, ar^2, ar^3, ar^4, \&c.$$

In this kind of feries each term is the product of that which precedes it and a conftant number r, which is called the common ratio of the terms. The fecond of the above examples is a particular cafe of a geometrical feries.

3. *Harmonic Series* is that in which the firft of any three of its confecutive terms is to the third, as the difference between the firft and fecond to the difference between the fecond and third: hence we readily find that putting a and b for its two firft terms, its general form will be

$$a, b, \frac{ab}{2a-b}, \frac{ab}{3a-2b}, \frac{ab}{4a-3b}, \&c.$$

If we fuppofe $a=1$ and $b=\frac{1}{2}$, we get

$$1, \tfrac{1}{2}, \tfrac{1}{3}, \tfrac{1}{4}, \tfrac{1}{5}, \tfrac{1}{6}, \&c.$$

as a particular example of a harmonic feries.

4. *Recurring Series.* Let its terms be denoted by

$$A, B, C, D, E, F, \&c.$$

Then, we fhall form a recurring feries, if m and n being put for given quantities, we take

$$C=mA+nB, \qquad E=mC+nD,$$
$$D=mB+nC, \qquad F=mD+nE.$$

For example, let us fuppofe $A=1$, $B=2x$, $m=4x^2$, $n=3x$; then $C=10x^2$, $D=38x^3$, $E=154x^4$, $F=614x^5$, fo that the firft fix terms of the feries are

$$1, 2x, 10x^2, 38x^3, 154x^4, 614x^5.$$

We have here fuppofed each term to be formed from the two which come immediately before it; but the name *recurring feries* is given to every one in which the terms are formed in like manner from fome affigned number of the terms which precede that fought. Thus, putting as before A, B, C, D, &c. for the terms of the feries, and m, n, p, q for given quantities, we fhall have another recurring feries, if we fuppofe them fo related that

Series.

$$mA+nB+pC+qD=0,$$
$$mB+nC+pD+qE=0,$$
$$mC+nD+pE+qF=0,$$

The two feries of quantities fin. a, fin. $2a$, fin. $3a$, &c. and cof. a, cof. $2a$, cof. $3a$, &c. are both recurring, as is manifeft from the law which connects the quantities one with another. (See ALGEBRA, §. 358.).

(3.) As in general it is the fum of the terms of a feries which is the object of inveftigation, it is ufual to connect them by the fign + or —, and to apply the name *feries* to the expreffion thus formed. Accordingly

$$1+3+5+7+9\cdots+\left\{1+2(n-1)\right\}$$

(where n denotes the number of terms) is called an arithmetical feries; and in like manner

$$1+\tfrac{1}{2}+\tfrac{1}{4}+\tfrac{1}{8}\cdots+\frac{1}{2^{n-1}}$$

is a geometrical feries.

(4.) A feries may either confift of a definite number of terms, or their number may be fuppofed greater than any that can be affigned, and in this cafe the feries is faid to be *infinite*. The number of terms of a feries may be infinite, and yet their fum finite. This is true; for example, of the feries

$$\tfrac{1}{2}+\tfrac{1}{4}+\tfrac{1}{8}+\tfrac{1}{16}+\&c.$$

which is equivalent to unity, or 1.

(5.) We have already treated of feveral branches of the doctrine of feries in the articles ALGEBRA, FLUXIONS and LOGARITHMS; and in particular we have given four different methods for expanding a quantity into a feries, viz.

1. By *Divifion* or *Evolution.* (See ALGEBRA, § 78, and § 260.).

2. By *the Method of Indeterminate Coefficients.* (ALGEBRA, § 261.).

3. By *the Binomial Theorem.* (ALGEBRA, § 263—§ 269.).

4. By *Taylor's Theorem.* (FLUXIONS, § 66—§ 72.).

We fhall here treat briefly of another branch of the theory, namely, how to find the fum of any propofed number of terms of certain feries, or the fum of their terms continued *ad infinitum*, when that fum is finite.

(6.) There is a great analogy between the terms of a feries and the ordinates of a curve which are fuppofed to ftand upon the axis at equal diftances from one another, the firft ordinate reckoned from the extremity of the axes being analogous to the firft term of the feries, the fecond ordinate to the fecond term, and fo on. From this analogy it follows immediately, that like as the nature of a curve is indicated by an equation expreffing the value of an indefinite ordinate in terms of its correfponding abfciffa, fo alfo the nature of a feries may be fhown by an equation which fhall exprefs the relation between any term; and the number that denotes the place or order of that term in the feries. In conformity

conformity to this method, putting the symbols $T_{(1)}$, $T_{(2)}$, $T_{(3)}$, &c. to denote the terms of any series whatever, we may express it generally thus.

$$T_{(1)}, + T_{(2)}, + T_{(3)}, \cdots + T_{(v)}$$

where the characters (1), (2), are meant to denote the place or order of the terms to which they are joined, (the first term being supposed to have the place 1, the second term the place 2, and so on) and (v) is put for any indefinite number.

The nature of the arithmetical series

$$a+(a+d)+(a+2d)+(a+3d)+, \text{ \&c.}$$

will be defined by the equation

$$T_{(v)} = a+(v-1)d,$$

and, in like manner, the nature of the geometrical series

$$a+ar+ar^2+ar^3+, \text{ \&c.}$$

will be expressed by the equation

$$T_{(v)} = ar^{v-1}.$$

(7.) As the expression for the value of the indefinite term $T_{(v)}$ becomes identical with all the terms of the series in succession, by substituting the numbers 1, 2, 3, &c. one after another for v, that expression is called the *general term* of the series. In the series

$$a+b+\frac{ab}{2a-b}+\frac{ab}{3a-2b}+\frac{ab}{4a-3b}+, \text{ \&c.}$$

the general term is evidently $\dfrac{ab}{(v-1)a-(v-2)b}$.

(8.) We shall now investigate the sum of any number of terms of such series as have their general terms expressed by any one of the following algebraic functions

$$v, \ \frac{v(v+1)}{1\cdot 2}, \ \frac{v(v+1)(v+2)}{1\cdot 2\cdot 3}, \ \frac{v(v+1)(v+2)(v+3)}{1\cdot 2\cdot 3}, \text{ \&c.}$$

PROBLEM I. It is proposed to find the sum of n terms of the series of which the general term is the first function.

By putting 1, 2, 3, &c. to n successively for v, it appears that the series to be summed is

$$1+2+3+4\cdots+n.$$

Now, as $v=\dfrac{v(v+1)}{2}-\dfrac{(v-1)v}{2}$, we have, by putting in this formula 1, 2, 3, $\cdots$ to n successively for v,

$$1=\frac{1\cdot 2}{2}-0,$$
$$2=\frac{2\cdot 3}{2}-\frac{1\cdot 2}{2},$$
$$3=\frac{3\cdot 4}{2}-\frac{2\cdot 3}{2},$$
$$4=\frac{4\cdot 5}{2}-\frac{3\cdot 4}{2},$$
$$\cdots\cdots$$
$$n-1=\frac{(n-1)n}{2}-\frac{(n-2)(n-1)}{2},$$
$$n=\frac{n(n+1)}{2}-\frac{(n-1)n}{2}.$$

Let the sum of the quantities on each side of the sign $=$ be now taken; then, observing that each of the fractions on the right hand side, with the exception of $\dfrac{n(n+1)}{1\cdot 2}$, occurs twice, once with the sign $+$, and again with the sign $-$, by which it happens that their aggregate is $=0$, it is evident that we have

$$1+2+3+4\cdots+n=\frac{n(n+1)}{1\cdot 2}.$$

PROB. II. It is proposed to sum n terms of the series having for its general term the second function

$$\frac{v(v+1)}{1\cdot 2}.$$

This series, by substituting 1, 2, 3, &c. successively for v, is found to be

$$\frac{1\cdot 2}{1\cdot 2}+\frac{2\cdot 3}{1\cdot 2}+\frac{3\cdot 4}{1\cdot 2}\cdots+\frac{n(n+1)}{1\cdot 2}.$$

We now, following the mode of proceeding employed in last problem, put the expression $\dfrac{v(v+1)}{1\cdot 2}$ under this form,

$$\frac{v(v+1)(v+2)}{1\cdot 2\cdot 3}-\frac{(v-1)v(v+1)}{1\cdot 2\cdot 3},$$

to which it is evidently equivalent, and, substituting 1, 2, 3, &c. successively for v, find

$$\frac{1\cdot 2}{1\cdot 2}=\frac{1\cdot 2\cdot 3}{1\cdot 2\cdot 3}-0,$$
$$\frac{2\cdot 3}{1\cdot 2}=\frac{2\cdot 3\cdot 4}{1\cdot 2\cdot 3}-\frac{1\cdot 2\cdot 3}{1\cdot 2\cdot 3},$$
$$\frac{3\cdot 4}{1\cdot 2}=\frac{3\cdot 4\cdot 5}{1\cdot 2\cdot 3}-\frac{2\cdot 3\cdot 4}{1\cdot 2\cdot 3},$$
$$\frac{4\cdot 5}{1\cdot 2}=\frac{4\cdot 5\cdot 6}{1\cdot 2\cdot 3}-\frac{3\cdot 4\cdot 5}{1\cdot 2\cdot 3},$$
$$\cdots\cdots$$
$$\frac{n(n+1)}{1\cdot 2}=\frac{n(n+1)(n+2)}{1\cdot 2\cdot 3}-\frac{(n-1)n(n+1)}{1\cdot 2\cdot 3}.$$

In this problem, as in the former, it appears that each quantity on the right side of the equations, except $\dfrac{n(n+1)(n+2)}{1\cdot 2\cdot 3}$, occurs twice, and with contrary signs; therefore, taking the aggregate of the terms on each side, we have

$$\frac{1\cdot 2}{1\cdot 2}+\frac{2\cdot 3}{1\cdot 2}+\frac{3\cdot 4}{1\cdot 2}+\frac{4\cdot 5}{1\cdot 2}\cdots+\frac{n(n+1)}{1\cdot 2}$$
$$=\frac{n(n+1)(n+2)}{1\cdot 2\cdot 3}.$$

(9.) It will be obvious, by a little attention to the solutions of these two problems, that in each the terms of the series to be summed are the differences betwixt the adjacent

Series. adjacent terms of another ſeries, namely, that which has for its general term the function next in order to the general term of the ſeries under conſideration; that is, the terms of the ſeries whoſe general term is v, are the differences betwixt thoſe of the ſeries having $\frac{v(v+1)}{1\cdot 2}$ for its general terms; and, again, the terms of this laſt are the differences of the terms of the ſeries having $\frac{v(v+1)(v+2)}{1\cdot 2\cdot 3}$ for its general term. Now as the ſum of the differences of any ſeries of quantities whatever which begins with o muſt neceſſarily be the laſt term of that ſeries *, it follows, that the ſum of all the terms of each of the ſeries we have conſidered muſt be equal to the laſt term of the next following ſeries; and this term is neceſſarily the expreſſion formed by ſubſtituting n for v in its general term, that is, the ſum of the ſeries $1+2+3\cdots+n$, which has v for its general term, is $\frac{n(n+1)}{1\cdot 2}$; and the ſum of the ſeries

$$\frac{1\cdot 2}{1\cdot 2}+\frac{2\cdot 3}{1\cdot 2}+\frac{3\cdot 4}{1\cdot 2}\cdots++\frac{n(n+1)}{1\cdot 2}$$
$$\text{is } \frac{n(n+1)(n+2)}{1\cdot 2\cdot 3}.$$

The next ſeries which has $\frac{v(v+1)(v+2)}{1\cdot 2\cdot 3}$ for its general term, as well as all that ſucceed, will be found to have the very ſame property, as may be proved as follows. Let p denote any term of the ſeries of natural numbers 1, 2, 3, &c. Then, becauſe

$$1=\frac{v+p}{p+1}-\frac{v-1}{p+1},$$

if we multiply theſe equals by the product of all the factors v, $\frac{v+1}{2}$, $\frac{v+2}{3}$, &c. to $\frac{v+p-1}{p}$, we get

$$\frac{v(v+1)(v+2)\cdots(v+p-1)}{1\cdot 2\cdot 3\cdots p}$$
$$=\begin{cases}\frac{v(v+1)(v+2)\cdots(v+p)}{1\cdot 2\cdot 3\cdots(p+1)}\\ -\frac{(v-1)v(v+1)\cdots(v+p-1)}{1\cdot 2\cdot 3\cdots(p+1)}.\end{cases}$$

Now, if in this identical equation we ſubſtitute the numbers 1, 2, 3, &c. to n ſucceſſively for v, the reſults obtained from its firſt member

$$\frac{v(v+1)(v+2)\cdots(v+p-1)}{1\cdot 2\cdot 3\cdots p}$$

will be a ſeries having this function for its general term, and the terms of which will evidently be the difference between the terms of another ſeries having the firſt part of the ſecond member of the equation, viz.

$$\frac{v(v+1)(v+2)\cdots(v+p)}{1\cdot 2\cdot 3\cdots(p+1)},$$

for its general term: Hence it will happen, as in the two foregoing problems, that the ſum of all the terms of the former ſeries will be equal to the laſt term of the latter; which concluſion may be expreſſed in the form of a theorem, as follows: Series.

THEOREM. *The ſum of* n *terms of a ſeries having for its general term the function,*

$$\frac{v(v+1)(v+2)\cdots(v+p-1)}{1\cdot 2\cdot 3\cdots p}$$

is equal to

$$\frac{n(n+1)(n+2)\cdots(n+p)}{1\cdot 2\cdot 3\cdots(p+1)}.$$

Or, ſetting aſide the denominators of the terms, we may expreſs the theorem thus: *The ſum of* n *terms of a ſeries, having for its general term the expreſſion*

$$v(v+1)(v+2)\cdots(v+p-1),$$

is equal to

$$\frac{n(n+1)(n+2)\cdots(n+p)}{p+1}.$$

We ſhall here give a few particular caſes of this laſt general formula.

I. $1+2+3+4\cdots+n=\frac{n(n+1)}{2}$.

II. $1\cdot 2+2\cdot 3+3\cdot 4+4\cdot 5\cdots+n(n+1)$
$=\frac{n(n+1)(n+2)}{3}$.

III. $1\cdot 2\cdot 3+2\cdot 3\cdot 4+3\cdot 4\cdot 5\cdots+n(n+1)(n+2)$
$=\frac{n(n+1)(n+2)(n+3)}{4}$.

(10.) By means of the above general theorem we may find the ſum of any number of terms of a ſeries compoſed of the powers of the terms of an arithmetical progreſſion, the general term of which will, in the ſimpleſt caſe, be v^p, p being a given number. The manner of doing this will appear from the following problems.

PROB. III. It is propoſed to find the ſum of n terms of the ſeries of ſquares $1+4+9+16+25+$ &c. or $1^2+2^2+3^2+4^2+5^2+$ &c.

The general term of this ſeries being v^2, we put it under this form, $v(v+1)-v$; hence we get by ſubſtituting 1, 2, 3, &c. for v,

$$\begin{aligned}1^2&=1\cdot 2-1,\\ 2^2&=2\cdot 3-2,\\ 3^2&=3\cdot 4-3,\\ 4^2&=4\cdot 5-4,\\ &\cdots\\ n^2&=n(n+1)-n.\end{aligned}$$

Therefore adding, we find

$$1^2+2^2+3^2+4^2\cdots+n^2$$
$$=\begin{cases}1\cdot 2+2\cdot 3+3\cdot 4+4\cdot 5\cdots+n(n+1)\\ -(1+2+3+4\cdots+n).\end{cases}$$

But

* For example, let the quantities be o, a, b, c, d; then it is manifeſt that $(a-o)+(b-a)+(c-b)+(d-c)=d$.

But by the general theorem (9.)

$$1\cdot 2+2\cdot 3+3\cdot 4\cdots+n(n+1)=\frac{n(n+1)(n+2)}{3},$$

and, $$1+2+3+4\cdots+n=\frac{n(n+1)}{2};$$

therefore $$1^2+2^2+3^2+4^2\cdots+n^2$$
$$=\frac{n(n+1)(n+2)}{3}-\frac{n(n+1)}{2}$$
$$=\frac{n(n+1)(2n+1)}{6}.$$

We might have arrived at the fame conclufion by confidering that fince v^2, the general term of the feries, is equivalent to $v(v+1)-v$, the feries muft be the difference between two others, one having $v(v+1)$ and the other v for its general term; for the fake of perfpicuity, however, we have put down the terms of all the three feries.

PROB. IV. It is propofed to find the fum of n terms of the feries

$$1^3+2^3+3^3+4^3+5^3+\ \&c.$$

The general term in this cafe is v^3; now to transform this function, fo as to deduce the fum of the feries from the general theorem, we affume

$$v^3=v(v+1)(v+2)+A\,v(v+1)+B\,v,$$

where A and B denote quantities which are to have fuch values as fhall render the two fides of the equation identical whatever be the value of v; taking now the product of the factors, we have

$$v^3=v^3+(A+3)v^2+(A+B+2)v,$$

Therefore, by the theory of indeterminate coefficients, (ALGEBRA, § 261.)

$$A+3=0,\ A+B+2=0:$$

Hence we find $A=-3$, $B=-A-2=1$; thus it appears that v being any number whatever,

$$v^3=v(v+1)(v+2)-3\,v(v+1)+v.$$

Now, let S denote the fum of n terms of the feries under confideration, which has v^3 for its general term, and put P, Q, R for the like fums of the three feries, whofe general terms are the functions $v(v+1)(v+2)$, $v(v+1)$ and v refpectively; then, it is evident that $S=P-3Q+R$. But by the theorem, (9.)

$$P=\frac{n(n+1)(n+2)(n+3)}{4},$$
$$Q=\frac{n(n+1)(n+2)}{3},$$
$$R=\frac{n(n+1)}{2},$$

therefore, $$S=\frac{n(n+1)(n+2)(n+3)}{4}$$
$$-n(n+1)(n+2)+\frac{n(n+1)}{2},$$

and by proper reduction, S, or

$$1^3+2^3+3^3+4^3\cdots+n^3=\frac{n^2(n+1)^2}{4}.$$

Corollary. We have found (PROB. I.) that

$$1+2+3+4\cdots+n=\frac{n(n+1)}{2},$$

therefore, comparing this with the refult juft now obtained, it is evident that

$$(1+2+3+4\cdots+n)^2=1^3+2^3+3^3+4^3\cdots+n^3;$$

this is a very curious and elegant property of numbers.

(11.) It is manifeft that by the mode of proceeding employed in laft problem we may inveftigate the fum of n terms of the feries

$$1^m+2^m+3^m+4^m+\ \&c.$$

m being any whole pofitive number whatever: and indeed in the very fame way we may find the fum of any number of terms of a feries, whofe general term is

$$a+b\,v+c\,v^2+d\,v^3+\ \&c.$$

where a and b, &c. denote given numbers; namely, by transforming it into a function of the form

$$A+B\,v+C\,v(v+1)+D\,v(v+1)(v+2)+\ \&c.$$

where A, B, and C, &c. denote conftant quantities. Our limits, however, will not allow us to go into particulars.

(12.) The next clafs of feries we fhall confider, comprehends fuch as may be formed by the fucceffive fubftitution of a, $a+1$, $a+2$, &c. (a being put for any given quantity whatever) in the feries of functions

$$\frac{1}{v(v+1)},\ \frac{1}{v(v+1)(v+2)},\ \frac{1}{v(v+1)(v+2)(v+3)},\ \&c.$$

We fhall begin with the firft of thefe.

PROB. V. It is propofed to find the fum of n terms of the feries

$$\frac{1}{a(a+1)}+\frac{1}{(a+1)(a+2)}+\frac{1}{(a+2)(a+3)}+\ \&c.$$

which is formed by fubftituting a, $a+1$, $a+2$, &c. fucceffively for v in the general term $\frac{1}{v(v+1)}$.

Whatever be the value of v, we have

$$\frac{1}{v(v+1)}=\frac{1}{v}-\frac{1}{v+1},$$

therefore, proceeding as in the foregoing problems, we get

$$\frac{1}{a(a+1)}=\frac{1}{a}-\frac{1}{a+1},$$
$$\frac{1}{(a+1)(a+2)}=\frac{1}{a+1}-\frac{1}{a+2},$$
$$\frac{1}{(a+2)(a+3)}=\frac{1}{a+2}-\frac{1}{a+3},$$
$$\cdots\cdots$$
$$\frac{1}{(a+n-2)(a+n-1)}=\frac{1}{a+n-2}-\frac{1}{a+n-1},$$
$$\frac{1}{(a+n-1)(a+n)}=\frac{1}{a+n-1}-\frac{1}{a+n}.$$

Here it is evident that the terms of the feries to be fummed

fummed are the differences betwixt every two adjoining terms of this other feries.

$$\frac{1}{a}+\frac{1}{a+1}+\frac{1}{a+2}+\frac{1}{a+3}\cdots+\frac{1}{a+n};$$

Hence it immediately follows, that the fum of all the terms of the former is the difference between the two extreme terms of the latter; that is

$$\frac{1}{a(a+1)}+\frac{1}{(a+1)(a+2)}\cdots+\frac{1}{(a+n-1)(a+n)}$$
$$=\frac{1}{a}-\frac{1}{a+n}.$$

If we fuppofe the feries to be continued *ad infinitum*, then, as n will be indefinitely great, and $\frac{1}{a+n}$ indefinitely fmall, the fum will be fimply $\frac{1}{a}$; or in other words, the fraction $\frac{1}{a}$ is a limit to the fum of the feries.

PROB. VI. Let it be required to find the fum of n terms of this feries.

$$\frac{1}{a(a+1)(a+2)}+\frac{1}{(a+1)(a+2)(a+3)}+$$
$$\frac{1}{(a+2)(a+3)(a+4)}+, \text{\&c.}$$

the general term in this cafe being $\frac{1}{v(v+1)(v+2)}$.

Becaufe $\frac{2}{v(v+2)}=\frac{1}{v}-\frac{1}{v+2}$, therefore, multiplying by $\frac{1}{2(v+1)}$, we have

$$\frac{1}{v(v+1)(v+2)}=\frac{1}{2}\left\{\frac{1}{v(v+1)}-\frac{1}{(v+1)(v+2)}\right\},$$

and hence, by fubftituting a, $a+1$, $a+2$, &c. fucceffively for v,

$$\frac{1}{a(a+1)(a+2)}=\frac{1}{2}\left\{\frac{1}{a(a+1)}-\frac{1}{(a+1)(a+2)}\right\}.$$
$$\frac{1}{(a+1)(a+2)(a+3)}=\frac{1}{2}\left\{\frac{1}{(a+1)(a+2)}-\frac{1}{(a+2)(a+3)}\right\}.$$
$$\frac{1}{(a+2)(a+3)(a+4)}=\frac{1}{2}\left\{\frac{1}{(a+2)(a+3)}-\frac{1}{(a+3)(a+4)}\right\}$$
$$\cdots\cdots$$
$$\frac{1}{(a+n-1)(a+n)(a+n+1)}$$
$$=\frac{1}{2}\left\{\frac{1}{(a+n-1)(a+n)}-\frac{1}{(a+n)(a+n+1)}\right\}.$$

Hence it appears that the terms of the feries to be fummed are the halves of the differences of the terms of the feries

$$\frac{1}{a(a+1)}+\frac{1}{(a+1)(a+2)}+\frac{1}{(a+2)(a+3)}\cdots$$
$$+\frac{1}{(a+n)(a+n+1)};$$

confequently, the fum of all the terms of the former is half the difference between the extreme terms of the latter, or is $=$

$$\frac{1}{2}\left\{\frac{1}{a(a+1)}-\frac{1}{(a+n)(a+n+1)}\right\}.$$

(13.) From thefe two particular cafes it is eafy to fee how we may fum the feries when the general term is

$$\frac{1}{v(v+1)(v+2)\ldots(v+p)},$$

p being any whole number whatever: for fince

$$\frac{p}{v(v+p)}=\frac{1}{v}-\frac{1}{v+p},$$

therefore, multiplying the denominaters by all the factors which are intermediate between v and $v+p$,

we have

$$\frac{p}{v(v+1)(v+2)\ldots(v+p)}=$$
$$\frac{1}{v(v+1)(v+2)\ldots(v+p-1)}-$$
$$\frac{1}{(v+1)(v+2)(v+3)\ldots(v+p)}.$$

Now the latter fide of this equation is a general expreffion for the difference between any two adjacent terms of a feries whofe general term is

$$\frac{1}{v(v+1)(v+2)\ldots(v+p-1)},$$

therefore the difference between the firft and laft terms of this feries muft be the fum of the feries whofe general term is the function on the other fide of the equation, viz.

$$\frac{p}{v(v+1)(v+2)\ldots(v+p)}.$$

Hence we have the following very general theorem.

THEOREM. *Let* a *denote any number whatever, and let* 1, 2, 3 . . . p *be a feries of numbers, each of which exceeds that before it by unity; the fum of* n *terms of a feries formed by fubftituting the numbers* a, a+1, a+2, &c. *to* a+n−1 *fucceffively for* v *in the function*

$$\frac{1}{v(v+1)(v+2)\ldots(v+p)}$$

is equal to

$$p\left\{\frac{1}{a(a+1)(a+2)\ldots(a+p-1)}-\frac{1}{(a+n)(a+n+1)(a+n+2)\ldots(a+n+p-1)}\right.$$

COROLLARY.

COROLLARY. *The same series continued ad infinitum is equal to*

$$\frac{1}{p}\,\frac{1}{a(a+1)(a+2)\cdots(a+p-1)}.$$

(14.) We shall now give a few examples of the application of this theorem.

Example 1. Required the sum of n terms of the series

$$\frac{1}{2\cdot 3\cdot 4\cdot 5}+\frac{1}{3\cdot 4\cdot 5\cdot 6}+\frac{1}{4\cdot 5\cdot 6\cdot 7}+\text{, \&c.}$$

The terms of this series are evidently produced by the successive substitution of the numbers 2, 3, 4, 5, &c. for v in the function

$$\frac{1}{v(v+1)(v+2)(v+3)};$$

therefore, comparing this expression with the general formula, we have $a=2$, $p=3$, and the sum required

$$=\tfrac{1}{3}\left\{\frac{1}{2\cdot 3\cdot 4}-\frac{1}{(2+n)(3+n)(4+n)}\right\}.$$

Ex. 2. Required the sum of the series

$$\frac{1}{1\cdot 4\cdot 7}+\frac{1}{4\cdot 7\cdot 10}+\frac{1}{7\cdot 10\cdot 13}+\frac{1}{10\cdot 13\cdot 16}+\text{, \&c.}$$

continued *ad infinitum*.

By a little attention it will appear that its terms are produced by the substitution of the numbers $\frac{1}{3}$, $1\frac{1}{3}$, $2\frac{1}{3}$, &c. successively for v in the function

$$\frac{1}{3v(3v+3)(3v+6)}=\frac{1}{27v(v+1)(v+2)}:$$

In this case then $a=\frac{1}{3}$, $p=2$, therefore the sum is

$$\frac{1}{2}\times\frac{1}{27}\,\frac{1}{\frac{1}{3}\times 1\frac{1}{3}}=\frac{1}{24}.$$

(15.) When the function from which the series is derived has not the very form required in the theorem, it may be brought to that form by employing suitable transformations, as in the two following examples.

Ex. 3. It is proposed to find the sum of the series

$$\frac{1}{1.4}+\frac{1}{2.5}+\frac{1}{3.6}+\frac{1}{4.7}+\text{, \&c.}$$

continued *ad infinitum*.

This series is evidently formed by the substitution of the numbers 1, 2, 3, &c. successively for v in the function $\frac{1}{v(v+3)}$. This expression, however, does not in its present form agree with the general formula, because the factors $v+1$, $v+2$ are wanting; therefore to transform it, we multiply its numerator and denominator by $(v+1)(v+2)$, and it becomes

$$\frac{(v+1)(v+2)}{v(v+1)(v+2)(v+3)};$$

we next assume its numerator

$$(v+1)(v+2)=A(v+2)(v+3)+B(v+3)+C,$$

and by multiplying get

$$v^2+3v+2=Av^2+(5A+B)v+(6A+3B+C);$$

therefore, that v may be indeterminate, we must make

$$A=1,\ 5A+B=3,\ 6A+3B+C=2,$$

from which equations we get $A=1$, $B=3-5A=-2$, $C=2-6A-3B=2$, so that

$$\frac{1}{v(v+3)}=\frac{(v+2)(v+3)-2(v+3)+2}{v(v+1)(v+2)(v+3)}$$
$$=\frac{1}{v(v+1)}-\frac{2}{v(v+1)(v+2)}$$
$$+\frac{2}{v(v+1)(v+2)(v+3)}.$$

Thus it appears that the proposed series is resolvable into three others, the general terms of which all agree with the theorem. Now the sum of the infinite series whose general term is $\frac{1}{v(v+1)}$ appears by the theorem to be $\frac{1}{a}$, or 1, because $a=1$, and the sum of the infinite series whose general term is $\frac{-2}{v(v+1)(v+2)}$, is in like manner found to be $\frac{-2}{2}+\frac{1}{1\cdot 2}=\frac{-1}{2}$; and lastly, the infinite series whose general term is $\frac{2}{v(v+1)(v+2)(v+3)}$ is $\frac{2}{3}\,\frac{1}{1\cdot 2\cdot 3}=\frac{1}{9}$; therefore, collecting these into one, the sum of the proposed series is $1-\frac{1}{2}+\frac{1}{9}=\frac{11}{18}$, the answer.

Ex. 4. Required the sum of the infinite series.

$$\frac{1}{2\cdot 3\cdot 4}+\frac{2}{3\cdot 4\cdot 5}+\frac{3}{4\cdot 5\cdot 6}+\frac{4}{5\cdot 6\cdot 7}+\text{, \&c.}$$

The terms of this series are evidently formed by the substitution of the numbers 2, 3, 4, successively in the function

$$\frac{v-1}{v(v+1)(v+2)}.$$

Now $v-1=v+2-3$; therefore,

$$\frac{v-1}{v(v+1)(v+2)}=\frac{1}{v(v+1)}-\frac{3}{v(v+1)(v+2)},$$

thus it appears that the proposed series is reducible to two others, one having its terms produced by the substitution of 2, 3, &c. for v in the function $\frac{1}{v(v+1)}$, and the other by a like substitution in the function $\frac{-3}{v(v+1)(v+2)}$. Now, by our theorem, the sum of the first of these is $\frac{1}{2}$, and that of the second is $\frac{-3}{2}$

$\frac{1}{2\cdot 3}$

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$\frac{1}{2 \cdot 3} = -\frac{1}{4}$, therefore the fum of the propofed feries is $\frac{1}{2} - \frac{1}{4} = \frac{1}{4}$.

From thefe examples it is fufficiently evident how the theorem is to be applied in other cafes; and it appears alfo that by means of it we can fum any feries whatever whofe general term is of the form

$$\frac{A}{v(1+v)} + \frac{B}{v(1+v)(v+1)} + \frac{C}{v(v+1)(v+2)(v+3)} +, \text{ \&c.}$$

or admits of being reduced to that form.

(16.) It deferves to be remarked that the feries

$$\frac{1}{1} + \frac{1}{2} + \frac{1}{3} + \frac{1}{4} + \frac{1}{5} +, \text{ \&c.}$$

which is of a very fimple form, and in appearance of the fame nature as thofe we have fummed, does not however admit of being treated in the fame manner; and indeed, if it be continued *ad infinitum*, its fum is infinite, that is, it exceeds any number which can be affigned. The truth of this affertion will be evident if we can fhew that a certain definite number of its terms, beginning with any propofed term, can always be found, the fum of which fhall exceed an unit or 1; for this being the cafe, as we can go on continually in affigning fuch fets of terms, we can conceive as many to be taken as there are units in any propofed number however great; and therefore their fum, and much more the fum of all the terms of the feries from its beginning to the end of the laft fets of terms will exceed that number. Now that this can always be done may be proved as follows:

Let the term of the feries from which we are to reckon be $\frac{1}{a}$, then, if the thing be poffible, and if n be the requifite number of terms, we muft have

$$\frac{1}{a} + \frac{1}{a+1} + \frac{1}{a+2} + \frac{1}{a+3} \cdots + \frac{1}{a+n-1} > 1.$$

Now becaufe

$$a\left(1+\frac{1}{a}\right)^2 = a+2+\frac{1}{a},$$

$$a\left(1+\frac{1}{a}\right)^3 = a+3+\frac{3}{a}+\frac{1}{a^2},$$

and in general,

$$a\left(1+\frac{1}{a}\right)^p = a+p+\frac{p \cdot p-1}{1 \cdot 2}\frac{1}{a} +, \text{ \&c.}$$

therefore, p being any whole number,

$a\left(1+\frac{1}{a}\right)^p > a+p$, and confequently

$$\frac{1}{a+p} > \frac{1}{a\left(1+\frac{1}{a}\right)^p};$$

hence it follows that the feries

$$\frac{1}{a} + \frac{1}{a+1} + \frac{1}{a+2} \cdots + \frac{1}{a+n-1}$$

will be greater than the other feries

$$\frac{1}{a} + \frac{1}{a\left(1+\frac{1}{a}\right)} + \frac{1}{a\left(1+\frac{1}{a}\right)^2} + \frac{1}{a\left(1+\frac{1}{a}\right)^3} \cdots + \frac{1}{a\left(1+\frac{1}{a}\right)^{n-1}}.$$

Now this laft being evidently a geometrical feries, of which the common ratio is $\frac{1}{1+\frac{1}{a}}$, its fum is

$$1+\frac{1}{a} - \frac{1}{\left(1+\frac{1}{a}\right)^{n-1}};$$

therefore, the fum of the feries

$$\frac{1}{a} + \frac{1}{a+1} + \frac{1}{a+2} + \frac{1}{a+3} \cdots + \frac{1}{a+n-1}$$

will always be greater than this expreffion; but if we fuppofe n fo great that the quantity $\left(1+\frac{1}{a}\right)^{n-1}$ is equal to, or exceeds a, which is evidently always poffible, then the above expreffion for the fum of the geometrical feries will be equal to 1, or will exceed 1; therefore, the fame number of terms of the feries $\frac{1}{a} + \frac{1}{a+1} + \frac{1}{a+2} + \frac{1}{a+3} +$, &c. will always exceed 1; now this is the property of the feries we propofed to demonftrate.

When $a = \left(1+\frac{1}{a}\right)^{n-1}$, then $a^2 = a\left(1+\frac{1}{a}\right)^{n-1}$, but this quantity is greater than $a+n-1$ the denominator of the laft term of the feries

$$\frac{1}{a} + \frac{1}{a+1} + \frac{1}{a+2} + \frac{1}{a+3} \cdots + \frac{1}{a+n-1},$$

the fum of which, we have proved, will upon that hypothefis exceed unity; much more then will the fum exceed unity if we fuppofe the feries continued until the denominator of its laft term be equal to, or greater than a^2.

Hence, beginning with the term $\frac{1}{2}$, it appears that

$$\tfrac{1}{2} + \tfrac{1}{3} + \frac{1}{4=2^2} > 1,$$

$$\tfrac{1}{5} + \tfrac{1}{6} \cdots + \frac{1}{25=5^2} > 1,$$

$$\tfrac{1}{26} + \tfrac{1}{27} \cdots + \frac{1}{676=26^2} > 1,$$

$$\tfrac{1}{677} + \tfrac{1}{678} \cdots + \frac{1}{458329=677^2} > 1,$$

&c.

Although the fum of the feries we have been confidering is infinite, yet it evidently increafes very flowly; indeed it is a limit to all fuch as have a finite fum; for every

every infinite feries, the terms of which decreafe fafter than the reciprocals of an arithmetical progreffion, is always finite.

(17.) We have already explained what is meant by a *recurring feries*, (2.) we fhall now treat briefly, firft, of their origin, next of the way in which they may be fummed, and laftly, of the manner of determining the *general term* of any particular feries.

The feries which is produced by the developement of a rational algebraic fraction has always the property which conftitutes the characteriftic of the clafs called *Recurring*, (2.) and on the other hand, any feries having that property being propofed, an algebraic fraction may be found by the expanfion of which the feries fhall be produced.

The fraction $\frac{1+2x}{1-x-x^2}$, for example, by dividing the numerator by the denominator is converted into the infinite feries.

$$1+3x+4x^2+7x^3+11x^4+18x^5+, \&c.$$

which is of fuch a nature that if T, T′, T″, denote any three of its fucceeding terms, their relation to one another is expreffed by the equation

$$T''=T x^2+T' x.$$

If we employ algebraic divifion to convert the fraction into a feries, the law of its terms will not appear fo readily as if we ufe the method of indeterminate coefficients. By this method we affume the fraction

$$=A+Bx+Cx^2+Dx^3+Ex^4, +\&c.$$

and hence, multiplying by the denominator, and bringing all the terms to one fide, as explained in ALGEBRA, § 261, we have

$$\left.\begin{matrix}A+B\\-1-A\\-2\end{matrix}\right\} x \left.\begin{matrix}+C\\-B\\-A\end{matrix}\right\} x^2 \left.\begin{matrix}+D\\-C\\-B\end{matrix}\right\} x^3+\ \&c. =0,$$

and hence,

$$\begin{array}{ll} A-1=0, & C-B-A=0, \\ B-A-2=0, & D-C-B=0, \\ & \&c. \end{array}$$

From thefe equations it appears that the law of the feries is fuch as we have affigned.

The equation expreffing the relation which fubfifts among a certain number of fucceeding terms of a recurring feries, is called its *fcale of Relation*. The fame name is alfo fometimes given to the equation expreffing the connection of the coefficients of the terms. Thus the fcale of relation of the foregoing feries is either

$$T''=T x+T' x^2,$$

where T, T′, and T″ denote any three fucceeding terms of the feries, or it is

$$R=P+Q,$$

where P, Q and R denote their numeral coefficients.

(18.) We come next to fhew how the fum of any propofed number of terms of a recurring feries may be found. Let the feries continued to n terms be

$$T_{(1)}+T_{(2)}+T_{(3)} \cdots +T_{(n-2)}+T_{(n-1)}+T_{(n)},$$

where the characters $T_{(1)}$, $T_{(2)}$, &c. denote the fucceffive terms, and the numbers (1), (2), &c. their order or place; and as whatever number of terms is contained in the fcale, the manner of fumming the feries is the fame, we fhall in what follows, for the fake of brevity, fuppofe that it confifts of three, in which cafe it may be expreffed thus,

$$p\,T_{(n-2)}+q\,T_{(n-1)}+r\,T_{(n)}=0,$$

where p, q, r denote certain given quantities.

The fcale of relation affords the following feries of equations,

$$\begin{array}{l} p\,T_{(1)}+q\,T_{(2)}+r\,T_{(3)}=0, \\ p\,T_{(2)}+q\,T_{(3)}+r\,T_{(4)}=0, \\ p\,T_{(3)}+q\,T_{(4)}+r\,T_{(5)}=0, \\ \cdots\cdots\cdots \\ p\,T_{(n-2)}+q\,T_{(n-1)}+r\,T_{(n)}=0. \end{array}$$

Taking now the fum of thefe equations, we get

$$\left.\begin{array}{l} p(T_{(1)}+T_{(2)}+T_{(3)} \cdots +T_{(n-2)}) \\ +q(T_{(2)}+T_{(3)}+T_{(4)} \cdots +T_{(n-1)}) \\ +r(T_{(3)}+T_{(4)}+T_{(5)} \cdots +T_{(n)}) \end{array}\right\}=0.$$

But, putting s for the fum of n terms of the feries, this equation may manifeftly be expreffed thus,

$$\left.\begin{array}{l} p\,(s-T_{(n)}-T_{(n-1)}) \\ +q\,(s-T_{(1)}-T_{(n)}) \\ +r\,(s-T_{(1)}-T_{(2)}) \end{array}\right\}=0.$$

Hence, after reduction, we find $s=$

$$\frac{p(T_{(n-1)}+T_{(n)})+q(T_{(1)}+T_{(n)})+r(T_{(1)}+T_{(2)})}{p+q+r},$$

From which it appears that in this cafe the fum depends only on the two firft and the two laft terms of the feries.

EXAMPLE. It is propofed to find from this formula the fum of n terms of the feries

$$1+2x+3x^2+4x^3+5x^4+\ \&c.$$

its fcale of relation being

$$x^2\,T_{(n-2)}-2x\,T_{(n-1)}+T_{(n)}=0.$$

Here $p=x^2$, $q=-2x$, $r=1$, therefore, obferving that the laft two terms of the feries muft be $(n-1)x^{n-2}$ and $n x^{n-1}$, we have, after fubftituting and reducing,

$$s=\frac{1-(n+1)x^n+n x^{n+1}}{1-2x+x^2}.$$

This formula will not apply in the cafe of $x=1$, becaufe then the numerator and denominator are each $=0$: but in fuch cafes as this we may find the value of the function which expreffes the fum by what is delivered at § 90, FLUXIONS.

(19.) The procefs by which we have determined the value of n terms of the feries $T_{(1)}+T_{(2)}+T_{(3)}+$ &c. will alfo apply to the finding the rational fraction from which the feries may be deduced, which is alfo the fum of the feries continued *ad infinitum*. For in this cafe the equation from which we have deduced the fum being

$$\left.\begin{array}{l} p\,(T_{(1)}+T_{(2)}+T_{(3)}+\ \&c.) \\ +q\,(T_{(2)}+T_{(3)}+T_{(4)}+\ \&c.) \\ +r\,(T_{(3)}+T_{(4)}+T_{(5)}+\ \&c.) \end{array}\right\}=0,$$

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that is,

$$ps+q(s-T_{(1)})+r(s-T_{(1)}-T_{(2)})=0,$$

we have

$$s=\frac{(q+r)T_{(1)}+rT_{(2)}}{p+q+r}.$$

For example, let it be required to find the fraction, which being developed produces the feries

$$1+2x+3x^2+4x^3+, \&c.$$

the fcale of relation of which is

$$x^2T_{(n-2)}-2xT_{(n-1)}+T_{(n)}+0.$$

Here $p=x^2$, $q=-2x$, $r=1$, $T_{(1)}=1$, $T_{(2)}=2x$; therefore, fubftituting in the formula, we get

$$\frac{1}{1-2x+x^2}=\frac{1}{(1-x)^2}$$

for the fraction required, or for the fum of the feries continued *ad infinitum*.

(20.) We come now to the laft branch of the theory of recurring feries which we propofed to confider, namely, how to find in any cafe the *general term*.

We fhall begin with the moft fimple, and fuppofe the fraction to be $\frac{a}{1-px}$, which being expounded into a feries by divifion, is

$$a+apx+ap^2x^2+ap^3x^3+, \&c.$$

here it is immediately manifeft that the general term is $ap^{n-1}x^{n-1}$.

Next let us fuppofe the fraction to be $\frac{a+bx}{1-\alpha x-\beta x^2}$. Let the two roots of the quadratic equation $1-\alpha x-\beta x^2=0$ be $x=\frac{1}{p}$, $x=\frac{1}{q}$, fo that $1-px=0$, and $1-qx=0$; therefore, $1-\alpha x-\beta x^2=(1-px)(1-qx)$, thus, we have

$$\frac{a+bx}{1-\alpha x-\beta x^2}=\frac{a+bx}{(1-px)(1-qx)}.$$

Let us affume this expreffion equal to

$$\frac{P}{1-px}+\frac{Q}{1-qx},$$

where P and Q denote quantities which are to be independent of x, then, reducing to a common denominator, we have

$$\frac{a+bx}{(1-px)(1-qx)}=\frac{P+Q-(qP+pQ)x}{(1-px)(1-qx)}.$$

Hence, that x may remain indeterminate, we muft make

$$P+Q=a,\ qP+pQ=-b,$$

and from thefe equations we get

$$P=\frac{ap+b}{p-q},\ Q=-\frac{aq+b}{p-q}.$$

Now, by the operation of divifion, we find

$$\frac{P}{1-px}=P+Ppx+Pp^2x^2+, \&c.$$

$$\frac{Q}{1-qx}=Q+Qqx+Qq^2x^2+, \&c.$$

therefore, fince $\frac{a+bx}{1-\alpha x-\beta x^2}=\frac{P}{1-px}+\frac{Q}{1-qx}$, it follows that the developement of the fraction $\frac{a+bx}{1-\alpha x-\beta x^2}$ which proceeds according to the powers of x, is

$$(P+Q)Pp+Qq)x+(Pp^2+Qq^2)x^2$$
$$+(Pp^3+Qq^3)x^3+, \&c.$$

And here it is evident that the general term is $(Pp^{n-1}+Qq^{n-1})x^{n-1}$.

Let us take as a particular example the fraction $\frac{1-x}{1-x-2x^2}$, which, when expanded into a feries, becomes

$$1+0x+2x^2+2x^3+6x^4+10x^5$$
$$+22x^6+42x^7+86x^8+, \&c.$$

Here, from the equation $1-x-2x^2=0$, we get $x=\frac{1}{2}$ and $x=-1$, fo that $1-2x$ and $1+x$ are divifors of the function $1-x-2x^2$, that is, $1-x-2x^2=(1+x)(1-2x)$; hence $p=-1$, $q=2$, and fince $a=1$, $b=-1$; therefore $P=\frac{2}{3}$, $Q=\frac{1}{3}$, and the general term $(Pp^{n-1}+Qq^{n-1})x^{n-1}$ becomes by fubftituting

$$\left\{\frac{2}{3}(-1)^{n-1}+\frac{1}{3}2^{n-1}\right\}x^{n-1}=\frac{2^{n-1}\pm 2}{3}x^{n-1},$$

where the fign $+$ is to be taken when n is an odd number; but the fign $-$ when n is even.

Sometimes the values of p and q will come out imaginary quantities; thefe, however, will be found always to deftroy one another when fubftituted in the general term.

Let us next fuppofe the fraction which produces a recurring feries to be

$$\frac{a+bx+cx^2}{1-\alpha x-\beta x^2-\gamma x^3}.$$

Let $x=\frac{1}{p}$, $x=\frac{1}{q}$, $x=\frac{1}{r}$ be the three roots of the cubic equation $1-\alpha x-\beta x^2-\gamma x^3=0$, then the denominator of the fraction will be the product of the three factors

$$1-px,\ 1-qx,\ 1-rx.$$

We muft now affume the fraction equal to the expreffion

$$\frac{P}{1-px}+\frac{Q}{1-qx}+\frac{R}{1-rx};$$

in which P, Q, R denote quantities which are independent of x.

The three terms of this expreffion are next to be reduced to a common denominator and collected into one, and the coefficients of the powers of x in the numerator of the refult are to be put equal to the like powers of x in the propofed fraction, we fhall then have

P+

$$P+Q+R=a,$$
$$(q+r)P+(p+r)Q+(p+q)R=-b,$$
$$q\,r\,P+p\,r\,Q+p\,q\,R=c,$$

and by these equations the values of P, Q, R may be found.

Let $\frac{P}{1-px}$, $\frac{Q}{1-qx}$, $\frac{R}{1-rx}$ be now resolved into series by division; then, adding the like powers of x in each we have

$$(P+Q+R)+(Pp+Qq+Rr)x+(Pp^2+Qq^2+Rr^2)x^2+,\ \&c.$$

for the series which is the developement of the fraction

$$\frac{a+bx+cx^2}{1-\alpha x-\beta x^2-\gamma x^3}$$

and here the general term is evidently

$$(Pp^{n-1}+Qq^{n-1}+Rr^{n-1})x^{n-1};$$

and in the very same manner may the general term be found in every case in which the denominator of the fraction admits of being resolved into unequal factors.

(21.) Let us now suppose the fraction to have the form $\frac{a+bx}{(1-px)^2}$, the denominator being the product of two equal factors; this fraction cannot be decomposed into other fractions, the denominators of which are the simple factors of its denominator. We may, however, transform it into two, which shall have their numerators constant quantities by proceeding as follows: Assume the numerator $a+bx=P+Q(1-px)$, then, that x may remain indeterminate, we must have $P+Q=a$, $-pQ=b$, therefore

$$Q=-\frac{b}{p},\ P=a+\frac{b}{p}.$$

The assumption of $a+bx=P+Q(1-px)$ gives us therefore

$$\frac{a+bx}{(1-px)^2}=\frac{P}{(1-px)^2}+\frac{Q}{1-px}.$$

Now, putting the first term of the latter side of this equation under the form $P(1-px)^{-2}$, it is resolved by the binomial theorem into the series

$$P(1+2px+3p^2x^2+4p^3x^3+,\ \&c.);$$

the other fraction $\frac{Q}{1-px}$ being expanded into a series is

$$Q+Qpx+Qp^2x^2+,\ \&c.$$

Therefore, the complete developement of $\frac{a+bx}{(1-px)^2}$ is

$$P+Q+(2P+Q)px+(3P+Q)p^2x^2+,\ \&c.$$

and here the general term is manifestly $(nP+Q)p^{n-1}x^{n-1}$, or, substituting for P and Q their values,

$$\left\{npa+(n-1)b\right\}p^{n-2}x^{n-1}.$$

(22.) In general, whatever be the form of the fraction from which a recurring series is derived, to determine the general term we must decompose the fraction into others which may be as simple as possible; and provided it be rational, and the highest power of x in the numerator at least one degree less than the highest power in the denominator, it may be always decomposed into others having one or other of these two forms

$$\frac{P}{1-px},\ \frac{Q}{(1-qx)^n},$$

in which expressions P, Q, p, and q, denote quantities independent of x. Each partial fraction gives a recurring series, the general term of which will be sufficiently obvious; and as the series belonging to the original fraction, is the sum of these series, so also its general term will be the sum of all their general terms.

We have now treated of some of the more general methods of summing series which admit of being explained by the common principles of algebra; but the subject is of great extent, and to treat of it so as to give a tolerable notion of its various branches, would require more room than could with propriety be spared on such a work as ours.

(23). The fluxionary calculus affords a method, almost the only general one we possess, of summing series. The general principles upon which it is applied may be stated briefly as follows. Since the fluent of any fluxion containing one variable quantity may always be expressed by a series, on the contrary every series may be regarded as the expression of a fluent: when any series then is proposed, we must endeavour to find the fluxional expression of which that series is the fluent; and as we can always find the fluent of a fluxion, at least by approximation, within given limits; we may thence determine, if not the exact, at least the approximate value of any infinite series. We shall now shew how this principle may be applied in some particular cases.

Problem I. It is proposed to find the sum of n terms of the series

$$x+2x^2+3x^3+4x^4\cdots+nx^n.$$

Let the sum be denoted by s. Then, multiplying all the terms by $\frac{\dot{x}}{x}$ we have

$$\frac{s\dot{x}}{x}=\dot{x}+2x\dot{x}+3x^2\dot{x}+4x^3\dot{x}\cdots+nx^{n-1}\dot{x}$$

Let the fluent of both sides be now taken, and the result is

$$\int\frac{s\dot{x}}{x}=x+x^2+x^3+x^4\cdots+x^n.$$

Now the series on the right-hand side of this equation is a geometrical progression, the sum of which is known to be $\frac{x-x^{n+1}}{1-x}$, (Algebra, § 106). Therefore,

$$\int\frac{s\dot{x}}{x}=\frac{x-x^{n+1}}{1-x},$$

and

and, taking the fluxions,

$$\frac{\dot{s}x}{x}=\frac{\dot{x}-(n+1)x^n\dot{x}+nx^{n+1}\dot{x}}{(1-x)^2}.$$

Hence we find

$$s=\frac{x-(n+1)x^{n+1}+nx^{n+2}}{(1-x)^2}.$$

This result agrees with that formerly found (17.) of this article.

Problem II. It is proposed to sum the infinite series

$$1-\frac{1}{3}+\frac{1}{5}-\frac{1}{7}+\frac{1}{9}-\frac{1}{11}+, \text{ \&c.}$$

We may consider this series as a particular case of the more general series,

$$x-\frac{x^3}{3}+\frac{x^5}{5}-\frac{x^7}{7}+, \text{ \&c.}$$

namely, that in which $x=1$. Putting therefore the sum $=s$, and taking the fluxions, we have

$$\dot{s}=\dot{x}(1-x^2+x^4-x^6+, \text{ \&c.}).$$

Now the series in the parenthesis is obviously the developement of the rational fraction $\frac{1}{1+x^2}$ therefore, $\dot{s}=\frac{\dot{x}}{1+x^2}$, and taking the fluent $s=$ arc (tan. $=x$) $+c$, radius being unity. (Fluxions § 60.) Now when $x=0$, all the terms of the series vanish, so that in this case $s=0$; and as when $x=0$, arc. (tan. $=x$)$=0$; therefore c, the constant quantity added to complete the fluent is 0, and we have simply $s=$ arc. (tan. $=x$), and when $x=1$, then $s=\frac{1}{2}$ a quadrant $=.7853982$.

Problem III. Required the sum of the infinite series

$$\frac{x}{1\cdot 2}+\frac{x^2}{2\cdot 3}+\frac{x^3}{3\cdot 4}+\frac{x^4}{4\cdot 5}+, \text{ \&c.}$$

Putting s for the sum, and taking the fluxions, we get

$$\dot{s}=\frac{\dot{x}}{x^2}\left(\frac{x^2}{2}+\frac{x^3}{3}+\frac{x^4}{4}+\frac{x^5}{5}+, \text{ \&c.}\right)$$

Now the series in the parenthesis is evidently equal to $-x-$ Nap. log. $(1-x)$. (see Logarithms, page 76. column 1.); therefore

$$\dot{s}=-\frac{\dot{x}}{x}-\frac{\dot{x}}{x^2}\times \text{Nap. log. } (1-x).$$

To find the fluent, let us put v for the function $\frac{1}{x}$ log. $(1-x)$, then, taking its fluxion we have

$$\dot{v}=-\frac{\dot{x}}{x^2}\times\log.(1-x)-\frac{\dot{x}}{x(1-x)},$$

and $-\frac{\dot{x}}{x^2}\times\log.(1-x)=\dot{v}+\frac{\dot{x}}{x(1-x)}$,

therefore, substituting, we get

$$\dot{s}=\dot{v}+\frac{\dot{x}}{x(1-x)}-\frac{\dot{x}}{x}$$

$$=\dot{v}+\frac{\dot{x}}{1-x};$$

and taking the fluents,

$$s=v-\log.(1-x)+c$$
$$=\frac{\log.(1-x)}{x}-\log.(1-x)+c.$$

To determine the constant quantity c, let us take $x=0$, then, in this case all the terms of the series vanish so that $s=0$, also log. $(1-x)=$ log. $1=0$; and since in general $\frac{\log.(1-x)}{x}=\frac{1}{x}\left(-x-\frac{x^2}{2}-\frac{x^3}{3}\right.$ $\left.-, \text{ \&c.}\right)=-1-\frac{x}{2}-\frac{x^2}{3}-$, &c. when $x=0$, then $\frac{\log.(1-x)}{x}=-1$: therefore $0=-1+c$, and $c=1$; hence it appears that

$$s=\frac{\log.(1-x)}{x}-\log.(1-x)+1$$
$$=\frac{(1-x)\log.(1-x)}{x}+1.$$

Example, Let $x=\frac{1}{2}$, then our formula gives

$$\frac{1}{1\cdot 2\cdot 2}+\frac{1}{2\cdot 3\cdot 2^2}+\frac{1}{3\cdot 4\cdot 2^3}+\frac{1}{4\cdot 5\cdot 2^4}+, \text{ \&c.}$$
$=1-$ Nap. log. $2=.3068528$.

Problem IV. Let the series to be summed be

$$1+\frac{m}{n}x+\frac{m+1}{n+1}x^2+\frac{m+2}{n+2}x^3+, \text{ \&c.}$$

Putting s for this series let all its terms be multiplied by x^{n-1} so that the exponent of x in each may be identical with its denominater, the result is

$$sx^{n-1}=x^{n-1}+\frac{m}{n}x^n+\frac{m+1}{n+1}x^{n+1}+\frac{m+2}{n+2}x^{n+2}+, \text{ \&c.}$$

and hence taking the fluxions

$$\dot{s}x^{n-1}+(n-1)s\dot{x}x^{n-2}=(n-1)\dot{x}x^{n-2}+m\dot{x}x^{n-1}$$
$$+(m+1)\dot{x}x^n+(m+2)\dot{x}x^{n+1}+, \text{ \&c.}$$

Let both sides of this equation be now multiplied by x^{m-n}, and it becomes

$$\dot{s}x^{m-1}+(n-1)s\dot{x}x^{m-2}=(n-1)\dot{x}x^{m-2}+m\dot{x}x^{m-1}$$
$$+(m+1)\dot{x}x^m+(m+2)\dot{x}x^{m+1}+, \text{ \&c.}$$

Putting now the single character $\dot{p}$ for the fluxional expression which forms the first member of this equation, we get by taking the fluents of both sides,

$$p=\frac{n-1}{m-1}x^{m-1}+x^m+x^{m+1}+x^{m+2}+, \text{ \&c.}$$
$$=\frac{n-1}{m-1}x^{m-1}+x^m(1+x+x^2+x^3+, \text{ \&c}),$$

but the series in the parenthesis is the developement of $\frac{1}{1-x}$, therefore

$$p=\frac{n-1}{m-1}x^{m-1}+\frac{x^m}{1-x};$$

taking

Series.

taking now the fluxions, and substituting instead of $\dot{p}$ the expression it was put to represent, we get

$$\dot{s}x^{n-1}+(n-1)s\dot{x}x^{n-2}$$
$$=(n-1)\dot{x}x^{n-2}+\frac{m\dot{x}x^{n-1}}{1-x}+\frac{\dot{x}x^{n}}{(1-x)^2},$$

and this, after reduction, becomes

$$\dot{s}+\frac{n-1}{x}s\dot{x}=\frac{(n-1)\dot{x}}{x}+\frac{m\dot{x}}{1-x}+\frac{x\dot{x}}{(1-x)^2}.$$

This fluxional equation being of the first degree, and first order, its primitive equation may be found (from the general formula given in FLUXIONS, § 182.) to be

$$s=\frac{1}{x^{n-1}}\times\int\left\{(n-1)\dot{x}x^{n-2}+\frac{m\dot{x}x^{n-1}}{1-x}+\frac{\dot{x}x^{n}}{(1-x)^2}\right\};$$

and this again, by remarking that $\int(n-1)\dot{x}x^{n-2}=x^{n-1}$,

and that

$$\int\frac{m\dot{x}x^{n-1}}{1-x}=\frac{mx^{n}}{n(1-x)}-\int\frac{m\dot{x}x^{n}}{n(1-x)^2},$$

may be reduced to

$$s=1+\frac{mx}{n(1-x)}+\frac{n-m}{nx^{n-1}}\int\frac{x^{n}\dot{x}}{(1-x)^2}.$$

The remaining fluent $\int\frac{x^{n}\dot{x}}{(1-x)^2}$ may be found by § 109. FLUXIONS, and it must be so taken, that after being multiplied by $\frac{n-m}{nx^{n-1}}$, it shall vanish when $x=0$; for then this hypothesis will make the whole function which expresses the value of s vanish, except its first term 1, as it ought to do.

Example. Let us suppose $n=2$, then,

$$\int\frac{x^2\dot{x}}{(1-x)^2}=x+\frac{x}{1-x}+2\log.(1-x),$$

and

$$\frac{2-m}{2x}\int\frac{x^2\dot{x}}{(1-x)^2}=\frac{(2-m)x}{2(1-x)}$$
$$+\frac{2-m}{x}\log.(1-x),$$

the fluent being here taken as directed. In this case then, after collecting the terms, we get s, or

$$1+\frac{m}{2}x+\frac{m+1}{3}x^2+\frac{m+2}{4}x^3+, \&c.$$
$$=\frac{1}{1-x}+\frac{(2-m)}{x}\log.(1-x).$$

(24.) There is a branch of the doctrine of series which is of considerable importance in pure mathematics as well as in many physical inquiries, and in the science of astronomy; it is called the *Interpolation* of series.

To interpolate a series is to interpose among its terms others which shall be subject to the same law, or which shall be formed in the same manner as the original terms of the series; or in other words, it is to find the value of one or more terms by means of others which are given, and which may be either at equal or unequal intervals from one another, the places of the given terms as well as of those sought being supposed known.

It is easy to see that this problem may be applied to the construction of logarithmic tables; for we may regard the logarithms of the natural numbers 1, 2, 3, 4, &c. *ad infinitum* as the terms of a particular series of which the numbers themselves are then the indices. Having given the logarithms of some numbers we may by interpolating deduce from them the logarithms of others.

Again, in astronomy we may consider the numbers which express the successive observed positions of a celestial body as the terms of a series, their indices being the intervals of time between the observations, and some assumed epoch, and the problem we are considering will enable us to determine the position at any instant different from the times of actual observation, provided the intervals between the observations be small, and the instant for which the position is sought not very remote from those at which the observations were made.

(25.) With a view to illustrate the nature of the problem to be resolved, let us consider some particular case, as for example the arithmetical series

$$a,\ a+d,\ a+2d,\ a+3d,\ a+4d,\ \&c.$$

Let t and t' be two given terms of the series, which are at any distance from one another, and let n and n' be their indices, or numbers which denote their places in the series. Also let y be any term whatever and x its index. Then by the nature of an arithmetical series,

$$t=a+(n-1)d,\ t'=a+(n'-1)d,$$
$$y=a+(x-1)d,$$

Now, as there are here three equations, each involving the quantities a and d, we may eliminate both these quantities by the common rules, (ALGEBRA, Sect. VII.) and this being done, we get

$$(x-n')(t'-t)=(n'-n)(y-t');$$

and hence we find this expression,

$$y=\frac{x-n'}{n-n'}t+\frac{x-n}{n'-n}t',$$

which is a general formula for interpolating any arithmetical series, and it is observable, that it is entirely independent both of the first term and common difference.

Example. The 7th term of an arithmetical series is 15, and the 12th term is 25: It is required to find the 10th term.

Here $n=7,\ n'=12,\ x=10;$

$t=15,\ t'=25,\ y$ is sought.

Therefore by the formula,

$$y=\frac{2}{5}\times15+\frac{3}{5}\times25=21, \text{ the answer.}$$

(26.) The mode of investigation by which we have found a formula for the interpolation of an arithmetical series will apply also to others, if the law according to which the terms are formed be known; in general, however, the law of a series to be interpolated is either not

Series. Plate ccclxxvii.

not known, or it is not taken into account, and we only consider the absolute magnitudes of certain terms, and the numbers expressing their places in the series. To resolve the problem generally with these *data*, it is usual to proceed as follows: Let a straight line, AB, and a point A in it, be assumed as given in position, and let there be taken the segments AD, AD′, AD″, AD‴, &c. proportional to the numbers denoting the places of the terms of a series reckoned from any term assumed as a fixed origin, and at the points D, D′, D″ let there be erected perpendiculars proportional to the terms themselves. Let us now suppose a curve to pass through C, C′, C″, C‴, &c. then, if it be so chosen that its curvature may vary gradually in its progress from point to point, without any very abrupt changes of inflection, and moreover, if the terms (which we may suppose to be either at equal or unequal distances) are pretty near to one another, it is easy to conceive, that if AP be taken equal to the number expressing the place of a term between C″D″, C‴D‴ any two others, the term itself will, if not exactly, at least be nearly expressed by PQ, the ordinate to the curve.

As an infinite variety of curves may be found that shall pass through the same given points; in this respect the problem is unlimited; it is, however, convenient to assume such as are simple and tractable. The parabolic class possess these properties, and accordingly they are commonly employed.

Let us then express the ordinates CD, C′D′, C″D″, C‴D‴, &c. which are the given terms of the series by

$$t,\ t',\ t'',\ t''',\ \&c.$$

and the abscissæ AD, AD′, AD″, AD‴, or the numbers denoting the order of the terms by

$$n,\ n',\ n'',\ n''',\ \&c.$$

Put y for PQ, a term to be interpolated, and x for AP its place. Then, considering x and y as indefinite co-ordinates, a parabolic curve that shall pass through the points C, C′, C″, C‴, &c. will have for its equation

$$y = A + Bx + Cx^2 + Dx^3, +, \&c.$$

the number of terms on the right-hand side being supposed equal to that of the given points, and A, B, C, &c. being put to denote constant quantities. To determine these we must consider that when $x=n$, then $y=t$, and that when $x=n'$, then $y=t'$ and so on, therefore, substituting the successive corresponding values of x and y we get

$$\begin{aligned}
t &= A + Bn + Cn^2 + Dn^3 +, \&c.\\
t' &= A + Bn' + Cn'^2 + Dn'^3 +, \&c.\\
t'' &= A + Bn'' + Cn''^2 + Dn''^3 +, \&c.\\
t''' &= A + Bn''' + Cn'''^2 + Dn'''^3 +, \&c.\\
&\&c. \qquad \&c.
\end{aligned}$$

this series of equations must be continued until their number be the same as that of the coefficient, A, B, C, D, &c. If we now consider t, t', t'', &c. and n, n', n'', &c. as known, and A, B, C, &c. as unknown quantities, we may determine these last by eliminating them one after another from the above equations, as is taught in ALGEBRA, Sect. XVII. And the values of A, B, C, &c. being thus determined and substituted in the general equation, we shall have a general expression for y in terms of x the number denoting its place and known quantities; and this is in substance the solution originally given of the problem by Sir Isaac Newton, who proposed it in the third book of his *Principia* with a view to its application in astronomy.

A celebrated foreign mathematician (Lagrange) has, in the *Cahiers de l'Ecole Normale*, given a different form to the expression for y. He has observed that since, when x becomes n, n', n'', n''', &c. successively, then y becomes t, t', t'', t''', &c. It follows that the expression for y must have this form.

$$y = \alpha t + \beta t' + \gamma t'' + \delta t''' +, \&c.$$

where the quantities α, β, γ, &c. must be such functions of x, that if we put $x=n$, then $\alpha=1$ and $\beta=0$, $\gamma=0$, &c. and if we put $x=n'$, then $\alpha=0$, $\beta=1$; $\gamma=0$, &c. and again, if we make $x=n''$, then $x=0$, $\beta=0$, $\gamma=1$, &c. and so on. Hence it is easy to conclude that the values of α, β, γ, &c. must have the form

$$\begin{aligned}
\alpha &= \frac{(x-n')(x-n'')(x-n''')}{(n-n')(n-n'')(n-n''')}, \&c.\\
\beta &= \frac{(x-n)(x-n'')(x-n''')}{(n'-n)(n'-n'')(n'-n''')}, \&c.\\
\gamma &= \frac{(x-n)(x-n')(x-n''')}{(n''-n)(n''-n')(n''-n''')}, \&c.\\
\delta &= \frac{(x-n)(x-n')(x-n'')}{(n'''-n)(n'''-n')(n'''-n'')}, \&c.\\
&\&c.
\end{aligned}$$

and here the number of factors in the numerator and denominator must be each equal to the number of given points in the curve. This formula would be found to be identical with that which may be obtained by the method indicated in last article, if we were to take the actual product of the factors and arrange the whole expression according to powers of x. It possesses however one advantage over the other, viz. that of admitting of the application of logarithms.

We shall now shew the application of this formula.

Ex. 1. Having given the logarithms of 101, 102, 104, and 105, it is required to find the logarithm of 103.

In this case we may reckon the terms of the series forward from the first given term, viz. log. 101, so that we have

$$\begin{aligned}
t &= \text{log. } 101 = 2.0043214, & n&=0,\\
t' &= \text{log. } 102 = 2.0086002, & n'&=1,\\
y &= \text{log. } 103 = \text{term sought}, & x&=2,\\
t'' &= \text{log. } 104 = 2.0170333, & n''&=3,\\
t''' &= \text{log. } 105 = 2.0211893, & n'''&=4.
\end{aligned}$$

Substituting now in the general formula we get

$$\alpha = \frac{1\times-1\times-2}{-1\times-3\times-4} = -\frac{1}{6}, \quad \gamma = \frac{2\times1\times-2}{3\times2\times-1} = \frac{2}{3},$$

$$\beta = \frac{2\times-1\times-2}{1\times-2\times-3} = \frac{2}{3}, \quad \delta = \frac{2\times1\times-1}{4\times3\times1} = -\frac{1}{6},$$

$$\begin{aligned}
\text{Therefore } y &= -\frac{t}{6} + \frac{2t'}{3} + \frac{2t''}{3} - \frac{t'''}{6}\\
&= \tfrac{2}{3}(t'+t'') - \tfrac{1}{6}(t+t''')\\
&= 2.0128372 \text{ the answer.}
\end{aligned}$$

Ex.

Ex. 2. Given a comet's diſtance from the ſun on the following days at 12 at night, to find its diſtance December 20th.

December 12.	diſtance 301,	Dec. 24.	diſtance 715,
21.	620,	26.	772.

Here we ſhall eſtimate the places of the terms from the time of the firſt poſition, viz. December 12. Therefore

$$\begin{array}{ll} t = 301, & n = 0, \\ y \text{ is ſought}, & x = 8, \\ t' = 620, & n' = 9, \\ t'' = 715, & n'' = 12, \\ t''' = 772, & n''' = 14. \end{array}$$

In this caſe the general formula gives us

$$\alpha = \frac{1}{63},\ \beta = \frac{6}{45},\ \gamma = -\frac{2}{3},\ \delta = \frac{8}{35},$$

therefore

$$y = \frac{t}{63} + \frac{64t'}{45} - \frac{2t''}{3} + \frac{8t'''}{35}.$$
$$= 586.3 \text{ the anſwer.}$$

We ſhall conclude this article with a brief enumeration of the beſt works on the ſubject which we have been treating of.

Ars Conjectandi, (Jac. Bernoulli). *Methodus Differentialis*, (Newton). *Methodus Incrementorum*, (Taylor). *Methodus Differentialis, ſive Tractatus de Summatione et Interpolatione Serierum*, (Stirling). *Inſtitutiones Calcul. Diff.* (Euler). *Emerſon's Method of Increments*. The differential method, (ſame author). *Miſcellanea Analytica* (De Moivre). The various writings of Landen and Simpſon. *Theorie des Fonctions Analytiques*, (Lagrange). *Du Calcul des Derivation*, (Arbogart). *Traité des differences et des Series*, (a ſequel to Lacroix's work on the *Calcul Differential*, &c.). Dr Hutton's Mathematical and Philoſophical Tracts. An Eſſay on the Theory of the various orders of Logarithmic Tranſcendents, with an Inquiry into their applications to the Integral Calculus, and the Summation of Series, by W. Spence, &c. &c.

SERINGAPATAM, the capital of Myſore, formerly the dominions of Tippoo Sultan, is ſituated in an iſland of the Cavery river, about 290 or 300 miles from Madras, and in N. Lat. 12° 32′ and E. Long. 96° 47′, about four miles in length, by one and a half in breadth, acroſs the middle, where it is likewiſe higheſt, whence it gradually falls and narrows towards the extremities. The weſt end of the iſland, on which there is a fort of conſiderable ſtrength, ſlopes more, eſpecially towards the north; and the ground riſing on the oppoſite ſide of the river commands a diſtinct view of every part of the fort. The fort and outworks occupy about a mile of the weſt end of the iſland, and are diſtinguiſhed by magnificent buildings, and ancient Hindoo pagodas, contraſted with the more lofty and ſplendid monuments lately raiſed in honour of the Mahometan faith. The great garden, called the *Laul Baug*, covers about as much of the eaſt end of the iſland as the fort and outworks do of the weſt; and the whole intermediate ſpace, except a ſmall incloſure on the north bank near the fort, was, before the laſt war, filled with houſes, and formed an extenſive ſuburb, of which the greateſt part was deſtroyed by Tippoo to make room for batteries to defend the iſland when attacked by the combined forces of Earl Cornwallis and the Mahratta chiefs in February 1792. This ſuburb, or town of modern ſtructure, is about half a mile ſquare, divided into regular croſs ſtreets, all wide, and ſhaded on each ſide by trees. It is ſurrounded by a ſtrong mud wall, contains many good houſes, and ſeems to have been preſerved by the Sultan for the accommodation of merchants, and for the convenience of troops ſtationed on that part of the iſland for its defence. A little to the eaſtward of the town is the entrance to the great garden, which was laid out in regular ſhady walks of large cypreſs trees, and abounding with fruit-trees, flowers, and vegetables of every deſcription. It poſſeſſed all the beauty and elegance of a country retirement, and was dignified by the mauſoleum of Hyder, and a ſuperb new palace built by his ſon. This noble garden was devoted to deſtruction; and the trees which had ſhaded their proud maſter, and contributed to his pleaſures, were formed into the means of protecting his enemies in ſubverting his empire. "Before that event, ſo glorious to the arms of England, this inſulated metropolis (ſays Major Dirom) muſt have been the richeſt, moſt convenient, and beautiful ſpot poſſeſſed in the preſent age by any native prince in India; but when the allies left it, the Sultan's fort and city only remained in repair amidſt all the wrecks of his former grandeur, the iſland preſenting nothing but the appearance of wretched barrenneſs. Tippoo is a man of talents, enterpriſe, and great wealth; but, in the opinion of our author, the remaining years of his ill-fated life will be unequal to renew the beauties of his terreſtrial paradiſe." This prediction was more than verified in the fate of Tippoo; for he loſt his life in bravely defending his capital, which was taken by aſſault in 1799 by the Britiſh troops under General Baird. See INDIA, N° 183.

SERINGHAM, an iſland of Indoſtan, formed about ſix miles north-weſt of Trinchinopoly by the river Cavery, which divides itſelf into two branches: that to the northward takes the name of *Coleroon*, but the ſouthern branch preſerves its old name the *Cavery*. Each of theſe rivers, after a courſe of about 90 miles, empty themſelves into the ſea; the Coleroon at Devicottah, and the Cavery near Tranquebar, at about 20 miles diſtance from one another. In this iſland, facing Trinchinopoly, ſtood a famous pagoda ſurrounded by ſeven ſquare walls of ſtone, 25 feet high and four feet thick. The ſpace between the outward and ſecond walls meaſured 310 feet, and ſo proportionably of the reſt. Each incloſure had four large gates, with a high tower; which were placed, one in the middle of each ſide of the incloſure, and oppoſite to the four cardinal points. The outward wall was about four miles in circumference, and its gateway to the ſouth was ornamented with pillars, ſome of which were ſingle ſtones 33 feet in length and five in diameter; while thoſe that formed the roof were ſtill larger; and in the inmoſt incloſure were the chapels.—About half a mile to the eaſt was another large pagoda called *Jumbikiſtna*, which had but one incloſure.

The pagoda of Seringham was held in great veneration, from a belief that it contained the identical image of of the god Wiftnou worfhipped by Brama; and pilgrims came here from all parts of India with offerings of money to procure abfolution. A large part of the revenue of the ifland was allotted for the maintenance of the Bramins who inhabited the pagoda; and thefe, with their families, formerly amounted to no fewer than 40,000 perfons, all maintained by the fuperftitious liberality of the adjacent country.

SERIOLA, a genus of plants belonging to the clafs fyngenefia, and in the natural fyftem ranged under the 49th order, *Compofitæ*. See BOTANY *Index*.

SERIPHIUM, a genus of plants belonging to the clafs fyngenefia. See BOTANY *Index*.

SERIPHUS, in *Ancient Geography*, one of the Cyclades or iflands in the Ægean fea, called *Saxum Seriphium* by Tacitus, as if all a rock; one of the ufual places of banifhment among the Romans. The people, *Seriphii*; who, together with the Siphnii, joined Greece againft Xerxes, were almoft the only iflanders who refufed to give him earth and water in token of fubmiffion, (Herodotus). *Seriphia Rana*, a proverbial faying concerning a perfon who can neither fing nor fay; frogs in this ifland being faid to be dumb, (Pliny).

SERMON, a difcourfe delivered in public, for the purpofe of religious inftruction and improvement.

Funeral SERMON. See *FUNERAL Orations*.

SERON OF ALMONDS, is the quantity of two hundred weight; of anife feed, it is from three to four hundred; of Caftile foap, from two hundred and a half to three hundred and three quarters.

SEROSITY, in *Medicine*, the watery part of the blood.

SERPENS, in *Aftronomy*, a conftellation in the northern hemifphere, called more particularly *Serpens Ophiuchi*. The ftars in the conftellation Serpens, in Ptolemy's catalogue, are 18; in Tycho's, 13; in Hevelius's, 22; and in the Britannic catalogue, 64.

SERPENS Biceps, or *Double-headed Snake*; a monfter of the ferpent kind, of which fome individuals are defcribed by naturalifts.

SERPENTES, *Serpents*, in the Linnæan fyftem of zoology, an order of animals belonging to the clafs of *amphibia*. See OPHIOLOGY.

The ferpent has been always confidered the enemy of man; and it has hitherto continued to terrify and annoy him, notwithftanding all the arts which have been practifed to deftroy it. Formidable in itfelf, it deters the invader from the purfuit; and from its figure, capable of finding fhelter in a little fpace, it is not eafily difcovered by thofe who would venture to encounter it. Thus poffeffed at once of potent arms, and inacceffible or fecure retreats, it baffles all the arts of man, though ever fo earneftly bent upon its deftruction. For this reafon, there is fcarcely a country in the world that does not ftill give birth to this poifonous brood, that feems formed to quell human pride, and reprefs the boafts of fecurity. Mankind have driven the lion, the tiger, and the wolf, from their vicinity; but the fnake and the viper ftill defy their power.

Their numbers, however, are thinned by human affiduity; and it is poffible fome of the kinds are wholly deftroyed. In none of the countries of Europe are they fufficiently numerous to be truly terrible. The various malignity that has been afcribed to European ferpents of old is now utterly unknown; there are not above three or four kinds that are dangerous, and their poifon operates in all in the fame manner. The drowfy death, the ftarting of the blood from every pore, the infatiable and burning thirft, the melting down the folid mafs of the whole form into one heap of putrefaction, faid to be occafioned by the bites of African ferpents, are horrors with which we are entirely unacquainted, and are perhaps only the creatures of fancy.

But though we have thus reduced thefe dangers, having been incapable of wholly removing them, in other parts of the world they ftill rage with all their ancient malignity. In the warm countries that lie within the tropics, as well as in the cold regions of the north, where the inhabitants are few, the ferpents propagate in equal proportion. But of all countries thofe regions have them in the greateft abundance where the fields are unpeopled and fertile, and where the climate fupplies warmth and humidity. All along the fwampy banks of the river Niger or Oroonoko, where the fun is hot, the forefts thick, and the men but few, the ferpents cling among the branches of the trees in infinite numbers, and carry on an unceafing war againft all other animals in their vicinity. Travellers have affured us, that they have often feen large fnakes twining round the trunk of a tall tree, encompaffing it like a wreath, and thus rifing and defcending at pleafure.—We are not, therefore, to reject as wholly fabulous the accounts left us by the ancients of the terrible devaftations committed by a fingle ferpent. It is probable, in early times, when the arts were little known, and mankind were but thinly fcattered over the earth, that ferpents, continuing undifturbed poffeffors of the foreft, grew to an amazing magnitude; and every other tribe of animals fell before them. It then might have happened, that ferpents reigned the tyrants of a diftrict for centuries together. To animals of this kind, grown by time and rapacity to 100 or 150 feet in length, the lion, the tiger, and even the elephant itfelf, were but feeble opponents. That horrible fœtor, which even the commoneft and the moft harmlefs fnakes are ftill found to diffufe, might, in thefe larger ones, become too powerful for any living being to withftand; and while they preyed without diftinction, they might thus alfo have poifoned the atmofphere around them. In this manner, having for ages lived in the hidden and unpeopled foreft, and finding, as their appetites were more powerful, the quantity of their prey decreafing, it is poffible they might venture boldly from their retreats into the more cultivated parts of the country, and carry confternation among mankind, as they had before defolation among the lower ranks of nature. We have many hiftories of antiquity, prefenting us fuch a picture, and exhibiting a whole nation finking under the ravages of a fingle ferpent. At that time man had not learned the art of uniting the efforts of many to effect one great purpofe. Oppofing multitudes only added new victims to the general calamity, and increafed mutual embarraffment and terror. The animal was therefore to be fingly oppofed by him who had the greateft ftrength, the beft armour, and the moft undaunted courage. In fuch an encounter, hundreds muft have fallen; till one, more lucky than the reft, by a fortunate blow, or by taking the monfter in its torpid interval, and furcharged with fpoil, might kill, and thus rid his country

country of the deſtroyer. Such was the original occupation of heroes; and thoſe who firſt obtained that name, from their deſtroying the ravagers of the earth, gained it much more deſervedly than their ſucceſſors, who acquired their reputation only for their ſkill in deſtroying each other. But as we deſcend into more enlightened antiquity, we find theſe animals leſs formidable, as being attacked in a more ſucceſsful manner. We are told, that while Regulus led his army along the banks of the river Bagrada in Africa, an enormous ſerpent diſputed his paſſage over. We are aſſured by Pliny, that it was 120 feet long, and that it had deſtroyed many of the army. At laſt, however, the battering engines were brought out againſt it; and theſe aſſailing it at a diſtance, it was ſoon deſtroyed. Its ſpoils were carried to Rome, and the general was decreed an ovation for his ſucceſs. There are, perhaps, few facts better aſcertained in hiſtory than this: an ovation was a remarkable honour; and was given only for ſome ſignal exploit that did not deſerve a triumph: no hiſtorian would offer to invent that part of the ſtory at leaſt, without being ſubject to the moſt ſhameful detection. The ſkin was kept for ſeveral years after in the Capitol; and Pliny ſays he ſaw it there. At preſent, indeed, ſuch ravages from ſerpents are ſcarcely ſeen in any part of the world; not but that, in Africa and America, ſome of them are powerful enough to brave the aſſaults of men to this day.

> *—Nequeunt expleri corda tuendo*
> *Terribiles oculos, vultum villoſaque ſetis*
> *Pectora.—* VIRGIL.

We have given a place to the preceding remarks, not ſo much for their accuracy as to ſhow what were formerly the ſentiments of mankind concerning this tribe of animals.

SERPENT, a muſical inſtrument, ſerving as a baſs to the cornet, or *ſmall ſhawm*, to ſuſtain a chorus of ſingers in a large edifice. It has its name *ſerpent* from its figure, as conſiſting of ſeveral folds or wreaths, which ſerve to reduce its length, which would otherwiſe be ſix or ſeven feet.

It is uſually covered with leather, and conſiſts of three parts, a mouth-piece, a neck, and a tail. It has ſix holes, by means whereof it takes in the compaſs of two octaves.

Merſennus, who has particularly deſcribed this inſtrument, mentions ſome peculiar properties of it, e. gr. that the ſound of it is ſtrong enough to drown 20 robuſt voices, being animated merely by the breath of a boy, and yet the ſound of it may be attempered to the ſoftneſs of the ſweeteſt voice. Another peculiarity of this inſtrument is, that great as the diſtance between the third and fourth hole appears, yet whether the third hole be open or ſhut, the difference is but a tone.

SERPENT, in *Mythology*, was a very common ſymbol of the ſun, and he is repreſented biting his tail, and with his body formed into a circle, in order to indicate the ordinary courſe of this luminary, and under this form it was an emblem of time and eternity. The ſerpent was alſo the ſymbol of medicine, and of the gods which preſided over it, as of Apollo and Æſculapius: and this animal was the object of very ancient and general worſhip, under various appellations and characters. In moſt of the ancient rites we find ſome alluſion to the ſerpent, under the ſeveral titles of Ob, Ops, Python, &c. This idolatry is alluded to by Moſes, (Lev. xx. 27.). The woman at Endor who had a familiar ſpirit is called Oub, or Ob, and it is interpreted Pythoniſſa. The place where ſhe reſided, ſays the learned Mr Bryant, ſeems to have been named from the worſhip then inſtituted; for Endor is compounded of *En-ador*, and ſignifies *fons Pythonis*, "the fountain of light, the oracle of the god Ador, which oracle was probably founded by the Canaanites, and had never been totally ſuppreſſed. His pillar was alſo called *Abbadir*, or *Abadir*, compounded of *ab* and *adir*, and meaning the ſerpent deity Addir, the ſame as Adorus.

In the orgies of Bacchus, the perſons who partook of the ceremony uſed to carry ſerpents in their hands, and with horrid ſcreams call upon Eva! Eva! Eva, being, according to the writer juſt mentioned, the ſame as epha, or opha, which the Greeks rendered *ophis*, and by it denoted a ſerpent. Theſe ceremonies and this ſymbolic worſhip began among the Magi, who were the ſons of Chus; and by them they were propagated in various parts. Wherever the Amonians founded any places of worſhip, and introduced their rites, there was generally ſome ſtory of a ſerpent. There was a legend about a ſerpent at Colchis, at Thebes, and at Delphi; and likewiſe in other places. The Greeks called Apollo himſelf Python, which is the ſame as Opis, Oupis, and Oub.

In Egypt there was a ſerpent named Thermuthis, which was looked upon as very ſacred; and the natives are ſaid to have made uſe of it as a royal tiara, with which they ornamented the ſtatues of Iſis. The kings of Egypt wore high bonnets, terminating in a round ball, and ſurrounded with figures of aſps; and the prieſts likewiſe had the repreſentation of ſerpents upon their bonnets.

Abadon, or Abaddon, mentioned in the Revelations xx. 2. is ſuppoſed by Mr Bryant to have been the name of the Ophite god, with whoſe worſhip the world had been ſo long infected. This worſhip began among the people of Chaldea, who built the city of Ophis upon the Tigris, and were greatly addicted to divination, and to the worſhip of the ſerpent. From Chaldea the worſhip paſſed into Egypt, where the ſerpent deity was called Canoph, Can-eph, and C'neph. It had alſo the name of Ob or Oub, and was the ſame as the Baſiliſcus or royal ſerpent, the ſame as the Thermuthis, and made uſe of by way of ornament to the ſtatues of their gods. The chief deity of Egypt is ſaid to have been Vulcan, who was ſtyled Opas. He was the ſame as Oſiris, the Sun, and hence was often called Ob-el, or Pytho-ſol, and there were pillars ſacred to him, with curious hieroglyphical inſcriptions bearing the ſame name; whence among the Greeks, who copied from the Egyptians, every thing gradually tapering to a point was ſtyled obelos, or obeliſcus.

As the worſhip of the ſerpent began among the ſons of Chus, Mr Bryant conjectures, that from thence they were denominated Ethiopians and Aithiopians, from Ath-ope or Ath-opes, the god whom they worſhipped, and not from their complexion; the Ethiopes brought theſe rites into Greece, and called the iſland where they firſt eſtabliſhed them, *Ellopia, Solis Serpentis inſula*, the ſame with *Eubœa*, or *Oubaia*, i. e. "the ſerpent iſland."

The same learned writer discovers traces of the serpent worship among the Hyperboreans, at Rhodes, named Ophiusa, in Phrygia, and upon the Hellespont, in the island Cyprus, in Crete, among the Athenians, in the name of Cecrops, among the natives of Thebes in Bœotia, among the Lacedemonians, in Italy, in Syria, &c. and in the names of many places, as well as of the people where the Ophites settled. One of the most early heresies introduced into the Christian church was that of the Ophitæ. Bryant's Analysis of Ancient Mythology, vol. i. p. 43, &c. p. 473, &c.

SERPENT Stones. See *CORNU Ammonis*, and *SNAKE-Stones.*

Sea-SERPENT. See *SEA Serpent.*

SERPENTARIA, SNAKE ROOT; a species of ARISTOLOCHIA. See BOTANY and MATERIA MEDICA *Index*.

SERPENTARIUS, in *Astronomy*, a constellation of the northern hemisphere, called also Ophiuchus, and anciently Æsculapius. The stars in the constellation Serpentarius, in Ptolemy's catalogue, are 29; in Tycho's 15; in Hevelius's 40; in the Britannic catalogue they are 74.

SERPENTINE, in general, denotes any thing that resembles a serpent; hence the worm or pipe of a still, twisted in a spiral manner, is termed a *serpentine worm.*

SERPENTINE Stone, a species of mineral belonging to the magnesian genus. See MINERALOGY *Index*.

SERPENTINE *verses*, are such as begin and end with the same word. As,

Ambo florentes ætatibus, Arcades ambo.

SERPENTINE, in the *Manege.* A horse is said to have a serpentine tongue, if it is always frisking and moving, and sometimes passing over the bit, instead of keeping in the void space, called the liberty of the tongue.

SERPICULA, a genus of plants belonging to the class monœcia. See BOTANY *Index*.

SERPIGO, in *Surgery*, a kind of herpes, popularly called a *tetter* or ringworm. See SURGERY.

SERPULA, a genus belonging to the class of vermes and to the order of testacea. See CONCHOLOGY *Index*.

SERRANUS, JOANNES, or John de Serres, a learned French Protestant, was born about the middle of the 16th century. He acquired the Greek and Latin languages at Lausanne, and devoted himself to the study of the philosophy of Aristotle and Plato. On his return to France he studied divinity. He began to distinguish himself in 1572 by his writings, but was obliged to forsake his country after the dreadful massacre of St Bartholomew. He became minister of Nismes in 1582, but was never regarded as a very zealous Calvinist: he has even been suspected, though without reason, of having actually abjured the Protestant religion. He was one of the four clergymen whom Henry IV. consulted about the Romish religion, and who returned for answer, *that Catholics might be saved.* He wrote afterwards a treatise in order to reconcile the two communions, entitled *De fide Catholica, sive de principiis religionis Christianæ, communi omnium Christianorum consensu, semper et ubique ratis.* This work was disliked by the Catholics, and received with such indignation by the Calvinists of Geneva, that many writers have affirmed that they poisoned the author. It is certain at least that he died at Geneva in 1598, at the age of 50. His principal works are, 1. A Latin translation of Plato, published by Henry Stephens, which owes much of its reputation to the elegance of the Greek copy which accompanies it. 2. A Treatise on the Immortality of the Soul. 3. *De statu religionis et reipublicæ in Francia.* 4. *Memoire de la 3me guerre civile et derniers troubles de France sous Charles IX. &c.* 5. *Inventaire general de l'Histoire de France, illustré par la conference de l'Eglise et de l'Empire, &c.* 6. *Recueil de chose memorable avenue en France sous Henri II. Français II. Charles IX. Henri III.* These three historical treatises have been justly accused of partiality and passion; faults which it is next to impossible for a contemporary writer to avoid, especially if he bore any part in the transactions which he describes. His style is exceedingly incorrect and inelegant; his mistakes too and misstatements of facts are very numerous.

SERRATED, in general, something indented or notched in the manner of a saw; a term much used in the description of the leaves of plants. See BOTANY *Index*.

SERRATULA, SAW-WORT, a genus of plants belonging to the syngenesia class, and in the natural system ranged under the 49th order, *Compositæ*. See BOTANY *Index*.

SERRATUS, in *Anatomy*, a name given to several muscles, from their resemblance to a saw. See ANATOMY, *Table of the Muscles*.

SERRISHTEHDAR, in Bengal, keeper of records or accounts.

SERTORIUS, QUINTUS, an eminent Roman general; (see SPAIN), under the history of which his exploits are related.

SERTULARIA, a genus belonging to the class of vermes, and to the order of zoophyta. See HELMINTHOLOGY *Index*.

SERVAL, MOUNTAIN CAT. See FELIS, MAMMALIA *Index*.

SERVANDONI, JOHN NICOLAS, a celebrated architect, was born at Florence in 1695. He rendered himself famous by his exquisite taste in architecture, and by his genius for decorations, fetes, and building. He was employed and rewarded by most of the princes in Europe. He was honoured in Portugal with the order of Christ: In France he was architect and painter to the king, and member of the different academies established for the advancement of these arts. He received the same titles from the kings of Britain, Spain, Poland, and from the duke of Wirtemberg. Notwithstanding these advantages, his want of economy was so great, that he left nothing behind him. He died at Paris in 1766. Paris is indebted to him for many of its ornaments. He made decorations for the theatres of London and Dresden. The French king's theatre, called *la salle des Machines*, was under his management for some time. He was permitted to exhibit some shows consisting of simple decorations: Some of these were astonishingly sublime; his "Descent of Æneas into Hell" in particular, and his "Enchanted Forest," are well known. He built and embellished a theatre at Chambor for Marefchal Saxe; and furnished the plan and the model of the theatre royal at Dresden. His genius for fetes was remarkable; he had the management of a great number in Paris, and even in London. He conducted one

Servandoni, Servant.

one at Lisbon given an account of a victory gained by the duke of Cumberland. He was employed frequently by the king of Portugal, to whom he presented several elegant plans and models. The prince of Wales, too, father to the present king, engaged him in his service; but the death of that prince prevented the execution of the designs which had been projected. He presided at the magnificent *fete* given at Vienna on account of the marriage of the archduke Joseph and the Infanta of Parma. But it would be endless to attempt an enumeration of all his performances and exhibitions.

SERVANT, a term of relation, signifying a person who owes and pays obedience for a certain time to another in quality of a master.

As to the several sorts of servants: It was observed, under the article LIBERTY, that pure and proper slavery does not, nay cannot, subsist in Britain: such we mean whereby an absolute and unlimited power is given to the master over the life and fortune of the slave. And indeed it is repugnant to reason, and the principles of natural law, that such a state should subsist anywhere. See SLAVERY.

The law of England therefore abhors, and will not endure, the existence of slavery within this nation: so that when an attempt was made to introduce it, by statute 1 Edw. VI. c. 3. which ordained, that all idle vagabonds should be made slaves, and fed upon bread, water, or small drink, and refuse-meat; should wear a ring of iron round their necks, arms, or legs; and should be compelled, by beating, chaining, or otherwise, to perform the work assigned them, were it ever so vile; the spirit of the nation could not brook this condition, even in the most abandoned rogues; and therefore this statute was repealed in two years afterwards. And now it is laid down, that a slave or negro, the instant he lands in Britain, becomes a freeman; that is, the law will protect him in the enjoyment of his person and his property. Yet, with regard to any right which the master may have lawfully acquired to the perpetual service of John or Thomas, this will remain exactly in the same state as before: for this is no more than the same state of subjection for life which every apprentice submits to for the space of seven years, or sometimes for a longer term. Hence, too, it follows, that the infamous and unchristian practice of withholding baptism from negro-servants, lest they should thereby gain their liberty, is totally without foundation, as well as without excuse. The law of England acts upon general and extensive principles: it gives liberty, rightly understood, that is, protection, to a Jew, a Turk, or a Heathen, as well as to those who profess the true religion of Christ; and it will not dissolve a civil obligation between master and servant, on account of the alteration of faith in either of the parties; but the slave is entitled to the same protection in England before as after baptism; and, whatever service the Heathen negro owed of right to his American master, by general, not by local law, the same (whatever it be) is he bound to render when brought to England and made a Christian.

1. The first sort of servants, therefore, acknowledged by the laws of England, are *menial servants*; so called from being *intra mœnia*, or domestics. The contract between them and their masters arises upon the hiring. If the hiring be general, without any particular time limited, the law construes it to be a hiring for a year; upon a principle of natural equity, that the servant shall serve and the master maintain him, throughout all the revolutions of the respective seasons; as well when there is work to be done, as when there is not: but the contract may be made for any larger or smaller term. All single men between 12 years old and 60, and married ones under 30 years of age, and all single women between 12 and 40, not having any visible livelihood, are compellable by two justices to go out to service in husbandry or certain specific trades, for the promotion of honest industry; and no master can put away his servant, or servant leave his master, after being so retained, either before or at the end of his term, without a quarter's warning; unless upon reasonable cause, to be allowed by a justice of the peace; but they may part by consent, or make a special bargain.

2. Another species of servants are called *apprentices*, (from *apprendre*, to learn); and are usually bound for a term of years, by deed indented or indentures, to serve their masters, and be maintained and instructed by them. This is usually done to persons of trade, in order to learn their art and mystery; and sometimes very large sums are given with them as a premium for such their instruction: but it may be done to husbandmen, nay, to gentlemen and others. And children of poor persons may be apprenticed out by the overseers, with consent of two justices, till 24 years of age, to such persons as are thought fitting; who are also compellable to take them: and it is held, that gentlemen of fortune, and clergymen, are equally liable with others to such compulsion: for which purposes our statutes have made the indentures obligatory, even though such parish-apprentice be a minor. Apprentices to trades may be discharged on reasonable cause, either at the request of themselves or masters, at the quarter-sessions, or by one justice, with appeal to the sessions; who may, by the equity of the statute, if they think it reasonable, direct restitution of a rateable share of the money given with the apprentice: and parish-apprentices may be discharged in the same manner by two justices. But if an apprentice, with whom less than 10 pounds hath been given, runs away from his master, he is compellable to serve out his time of absence, or make satisfaction for the same, at any time within seven years after the expiration of his original contract. See APPRENTICE and APPRENTICESHIP.

3. A third species of servants are *labourers*, who are only hired by the day or the week, and do not live *intra mœnia*, as part of the family; concerning whom the statutes before cited have made many very good regulations; 1. Directing that all persons who have no visible effects may be compelled to work; 2. Defining how long they must continue at work in summer and in winter: 3. Punishing such as leave or desert their work: 4. Empowering the justices at sessions, or the sheriff of the county, to settle their wages: and, 5. Inflicting penalties on such as either give or exact more wages than are so settled.

4. There is yet a fourth species of servants, if they may be so called, being rather in a superior, a ministerial, capacity; such as *stewards*, *factors*, and *bailiffs*; whom, however, the law considers as servants *pro tempore*, with regard to such of their acts as affect their master's or employer's property.

As to the manner in which this relation affects the master, the servant himself, or third parties, see the article *MASTER and Servant*.

For the condition of servants by the law of Scotland, see LAW.

SERVETISTS, a name given to the modern Antitrinitarians, from their being supposed to be the followers of Michael Servetus; who, in the year 1553, was burnt at Geneva, together with his books.

SERVETUS, MICHAEL, a learned Spanish physician, was born at Villaneuva, in Arragon, in 1509. He was sent to the university of Toulouse to study the civil law. The Reformation, which had awakened the most polished nations of Europe, directed the attention of thinking men to the errors of the Romish church and to the study of the Scriptures. Among the rest Servetus applied to this study. From the love of novelty, or the love of truth, he carried his inquiries far beyond the other reformers, and not only renounced the false opinions of the Roman Catholics, but went so far as to question the doctrine of the Trinity. Accordingly, after spending two or three years at Toulouse, he determined to go into Germany to propagate his new opinions, where he could do it with most safety. At Basil he had some conferences with Oecolampadius. He went next to Strasburg to visit Bucer and Capito, two eminent reformers of that town. From Strasburg he went to Hugenau, where he printed a book, intitled *De Trinitatis Erroribus*, in 1531. The ensuing year he published two other treatises on the same subject: in an advertisement to which, he informs the reader that it was not his intention to retract any of his former sentiments, but only to state them in a more distinct and accurate manner. To these two publications he had the courage to put his name, not suspecting that in age when liberty of opinion was granted, the exercise of that liberty would be attended with danger. After publishing these books, he left Germany, probably finding his doctrines not so cordially received as he expected. He went first to Basil, and thence to Lyons, where he lived two or three years. He then removed to Paris, where he studied medicine under Sylvius, Fernelius, and other professors, and obtained the degree of master of arts and doctor of medicine. His love of controversy involved him in a serious dispute with the physicians of Paris; and he wrote an Apology, which was suppressed by an edict of the Parliament. The misunderstanding which this dispute produced with his colleagues, and the chagrin which so unfavourable a termination occasioned, made him leave Paris in disgust. He settled two or three years in Lyons, and engaged with the Frellons, eminent printers of that age, as a corrector to their press. At Lyons he met with Pierre Palmier, the archbishop of Vienne, with whom he had been acquainted at Paris. That prelate, who was a great encourager of learned men, pressed him to accompany him to Vienne, offering him at the same time an apartment in his palace. Servetus accepted the offer, and might have lived a tranquil and happy life at Vienne, if he could have confined his attention to medicine and literature. But the love of controversy, and an eagerness to establish his opinions, always possessed him. At this time Calvin was at the head of the reformed church at Geneva. With Servetus he had been acquainted at Paris, and had there opposed his opinions. For 16 years Calvin kept up a correspondence with him, endeavouring to reclaim him from his errors. Servetus had read the works of Calvin, but did not think they merited the high eulogies of the reformers, nor were they sufficient to convince him of his errors. He continued, however, to consult him; and for this purpose sent from Lyons to Geneva three questions, which respected the divinity of Jesus Christ, regeneration, and the necessity of baptism. To these Calvin returned a civil answer. Servetus treated the answer with contempt, and Calvin replied with warmth. From reasoning he had recourse to abusive language; and this produced a polemical hatred, the most implacable disposition in the world. Calvin having obtained some of Servetus's papers, by means, it is said, not very honourable, sent them to Vienne along with the private letters which he had received in the course of their correspondence. The consequence was, that Servetus was arrested; but having escaped from prison, he resolved to retire to Naples, where he hoped to practise medicine with the same reputation which he had so long enjoyed at Vienne. He imprudently took his route through Geneva, though he could not but know that Calvin was his mortal enemy. Calvin informed the magistrates of his arrival; Servetus was apprehended, and appointed to stand trial for heresy and blasphemy. It was a law at Geneva, that every accuser should surrender himself a prisoner, that if the charge should be found false, the accuser should suffer the punishment in which he meant to involve the accused. Calvin not choosing to go to prison himself, sent one of his domestics to present the impeachment against Servetus. The articles brought against him were collected from his writings with great care; an employment which took up three days. One of these articles was, "that Servetus had denied that Judæa was a beautiful, rich, and fertile country; and affirmed, on the authority of travellers, that it was poor, barren, and disagreeable." He was also charged with "corrupting the Latin Bible, which he was employed to correct at Lyons, by introducing impertinent, trifling, whimsical, and impious notes of his own through every page." But the main article, which was certainly fatal to him, was, "that in the person of Mr Calvin, minister of the word of God in the church of Geneva, he had defamed the doctrine that is preached, uttering all imaginable injurious, blasphemous words against it."

Calvin visited Servetus in prison, and had frequent conferences with him: but finding that, in opposition to all the arguments he could employ, the prisoner remained inflexible in his opinions, he left him to his fate. Before sentence was passed, the magistrates of Geneva consulted the ministers of Bale, of Bern, and Zurich; and, as another account informs us, the magistrates of the Protestant Cantons of Swizzerland. And to enable them to form a judgment of the criminality of Servetus, they transmitted the writings of Calvin, with his answers. The general opinion was, that Servetus ought to be condemned to death for blasphemy. He was accordingly sentenced to be burnt alive on the 27th of October 1553. As he continued alive in the midst of the flames more than two hours, it is said, finding his torment thus protracted, he exclaimed, "Unhappy wretch that I am! Will the flames be insufficient to terminate my misery! What then! Will the hundred pieces of gold, and the rich collar which they took from me, Servetus, Service.

me, not purchafe wood enough to confume me more quickly !" "Though the fentence of death was paffed againft Servetus by the magiftrates of Geneva, with the approbation of a great number of the magiftrates and minifters of Switzerland, yet it is the opinion of moft hiftorians that this dreadful fentence was impofed at the inftigation of Calvin. This act of feverity for holding a fpeculative opinion, however erroneous and abfurd, has left a ftain on the character of this illuftrious reformer, which will attend the name of Calvin as long as hiftory fhall preferve it from oblivion. The addrefs and art which he ufed in apprehending Servetus, his inhumanity to him during his trial, his diffimulation and malevolence after his condemnation, prove that he was as much influenced by perfonal hatred as by a defire to fupport the intereft of religion, though probably, during the trial, Calvin believed he was performing a very pious action. This intolerant fpirit of Calvin and the magiftrates of Geneva gave the Roman Catholics a favourable opportunity to accufe the Proteftants of inconfiftency in their principles, which they did not fail to embrace. "How could the magiftrates (fays the author of the *Dictionnaire des Herefies*), who acknowledged no infallible interpretation of the Scriptures, condemn Servetus to death becaufe he explained them differently from Calvin; fince every man has the privilege to expound the Scripture, according to his own judgment, without having recourfe to the church? It is a great injuftice to condemn a man becaufe he will not fubmit to the judgment of an enthufiaft, who may be wrong as well as himfelf."

Servetus was a man of great acutenefs and learning, and well verfed in the arts and fciences. In his own profeffion his genius exerted itfelf with fuccefs. In his tract intitled *Chriftianifmi Reftitutio*, publifhed in 1553, he remarks, that the whole mafs of blood paffes through the lungs by the pulmonary artery and vein, in oppofition to the opinion which was then univerfally entertained, that the blood paffes through the partition which divides the two ventricles. This was an important ftep towards the difcovery of the circulation of the blood.

His works confift of Controverfial Writings concerning the Trinity; an edition of Pagninus's Verfion of the Bible, with a preface and notes, publifhed under the name of Michael Villanevanus; an Apology to the Phyficians of Paris; and a book intitled *Ratio Syruporum*. Mofheim has written in Latin a Hiftory of the Herefy and Misfortunes of Servetus, which was publifhed at Helmftadt, in 4to, in 1728. From the curious details which it gives it is extremely interefting.

SERVIA, a province of Turkey in Europe, bounded on the north by the rivers Danube and Save, which feparate it from Hungary; on the eaft, by Bulgaria; on the weft, by Bofnia: and on the fouth, by Albania and Macedonia. It is about 190 miles in length from eaft to weft; 95 in breadth from north to fouth; and is divided into four fangiacates. Two of thefe were ceded to the Chriftians in 1718, who united them into one. This continued till 1739, when the Turks were victorious; and then they were abandoned to the Turks by the treaty of Belgrade. Belgrade is the capital town.

SERVICE, in *Law*, is a duty which a tenant, on account of his fee, owes to his lord.

There are many divifions of fervices; as, 1. Into perfonal, where fomething is to be done by the tenant in perfon, as homage and fealty. 2. Real, fuch as wards, marriages, &c. 3. Accidental, including heriots, reliefs, and the like. 4. Entire, where, on the alienation of any part of the lands by a tenant, the fervices become multiplied. 5. Frank-fervice, which was performed by freemen, who were not obliged to perform any bafe fervice, but only to find a man and horfe to attend the lord into the army or to court. 6. Knight's fervice, by which lands were anciently held of the king, on paying homage, fervice in war, &c.

As in every free and well regulated fociety there muft be a diverfity of ranks, there muft be a great number of perfons employed in fervice, both in agriculture and domeftic affairs. In this country, fervice is a contract into which the fervant voluntarily enters; and the mafter's authority extends no farther than to the performance of that fpecies of labour for which the agreement was made.

"The treatment of fervants (fays that refpectable moralift Mr Paley), as to diet, difcipline, and accommodation, the kind and quantity of work to be required of them, the intermiffion, liberty, and indulgence to be allowed them, muft be determined in a great meafure by cuftom; for where the contract involves fo many particulars, the contracting parties expref a few perhaps of the principal, and by mutual underftanding refer the reft to the known cuftom of the country in like cafes.

Paley's Moral and Political Philofophy, p. 139.

"A fervant is not bound to obey the unlawful commands of his mafter; to minifter, for inftance, to his unlawful pleafures; or to affift him in unlawful practices in his profeffion; as in fmuggling or adulterating the articles which he deals in. For the fervant is bound by nothing but his own promife; and the obligation of a promife extends not to things unlawful.

"For the fame reafon, the mafter's authority does not juftify the fervant in doing wrong; for the fervant's own promife, upon which that authority is founded, would be none.

"Clerks and apprentices ought to be employed entirely in the profeffion or trade which they are intended to learn. Inftruction is their wages; and to deprive them of the opportunities of inftruction, by taking up their time with occupations foreign to their bufinefs, is to defraud them of their wages.

"The mafter is refponfible for what a fervant does in the ordinary courfe of his employment; for it is done under a general authority committed to him, which is in juftice equivalent to a fpecific direction. Thus, if I pay money to a banker's clerk, the banker is accountable: but not if I had paid it to his butler or his footman, whofe bufinefs it is not to receive money. Upon the fame principle, if I once fend a fervant to take up goods upon credit, whatever goods he afterwards takes up at the fame fhop, fo long as he continues in my fervice, are juftly chargeable to my account.

"The law of this country goes great lengths in intending a kind of concurrence in the mafter, fo as to charge him with the confequences of his fervants conduct. If an innkeeper's fervant rob his guefts, the innkeeper muft make reftitution; if a farrier's fervant lame your horfe, the farrier muft anfwer for the damage;

Service. mage; and still farther, if your coachman or carter drive over a passenger in the road, the passenger may recover from you a satisfaction for the hurt he suffers. But these determinations stand, I think, rather upon the authority of the law, than any principle of natural justice."

There is a grievance which has long and justly been complained of, the giving of good characters to bad servants. This is perhaps owing to carelessness, to a desire of getting rid of a bad servant, or to mistaken compassion. But such carelessness is inexcusable. When a man gives his sanction to the character of a bad servant, he ought to reflect on the nature and consequences of what he is doing. He is giving his name to a falsehood; he is deceiving the honest man who confides in his veracity; and he is deliberately giving a knave an opportunity of cheating an honest man. To endeavour to get quit of a bad servant in this way, is surely not less criminal than concealing the faults and disadvantages of an estate which is advertised for sale, and ascribing to it advantages which it does not possess. In this case, we know the sale would be reduced, and the advertiser disgraced. Many masters give characters to servants out of compassion; but it is to this mistaken compassion that the disorderly behaviour of servants is perhaps principally owing: for if the punishment of dishonesty be only a change of place (which may be a reward instead of a punishment), it ceases to be a servant's interest to be true to his trust.

We have said above that a master's authority over his servant extends no farther than the terms of contract; by which we meant, that a master could give no unreasonable orders to his servant, or such as was inconsistent with the terms of contract. But the relation between a master and servant is certainly closer than the mere terms of a contract: it is a moral as well as a legal relation. A master of a family ought to superintend the morals of his servants, and to restrain them from vices. This he may do by his example, by his influence, and authority. Indeed every man possessed of authority is guilty of criminal negligence if he does not exert his authority for promoting virtue in his inferiors; and no authority is so well adapted for this purpose as that of masters of families, because none operates with an influence so immediate and constant. It is wonderful how much good a nobleman or gentleman of fortune can do to his domestics by attending to their morals; and every master may be a blessing to individuals and to society, by exerting prudently that influence which his situation gives him over the conduct of his servant.

Choral SERVICE, in church-history, denotes that part of religious worship which consists in chanting and singing. The advocates for the high antiquity of singing, as a part of church-music, urge the authority of St Paul in its favour (Ephes. chap. v. ver. 19. and Colos. chap. iii. ver. 16.). On the authority of which passages it is asserted, that songs and hymns were, from the establishment of the church, sung in the assemblies of the faithful; and it appears from undoubted testimony, that singing, which was practised as a sacred rite among the Egyptians and Hebrews, at a very early period, and which likewise constituted a considerable part of the religious ceremonies of the Greeks and Romans, made a part of the religious worship of Christians, not only before churches were built, and their religion established by law, but from the first profession of Christianity. However, the era from whence others have dated the introduction of music into the service of the church, is that period during which Leontius governed the church of Antioch, *i. e.* between the year of Christ 347 and 356. See ANTIPHONY.

From Antioch the practice soon spread through the other churches of the East; and in a few ages after its first introduction into divine service, it not only received the sanction of public authority, but those were forbid to join in it who were ignorant of music. A canon to this purpose was made by the council of Laodicea, which was held about the year 372; and Zonanas informs us, that these canonical singers were reckoned a part of the clergy. Singing was introduced into the western churches by St Ambrose about the year 374, who was the institutor of the Ambrosian chant established at Milan about the year 386; and Eusebius (lib. ii. cap. 17.) tells us, that a regular choir, and method of singing the service, were first established, and hymns used, in the church at Antioch, during the reign of Constantine, and that St Ambrose, who had long resided there, had his melodies thence. This was about 230 years afterwards amended by Pope Gregory the Great, who established the Gregorian chant; a plain, unisonous kind of melody, which he thought consistent with the gravity and dignity of the service to which it was to be applied. This prevails in the Roman church even at this day: it is known in Italy by the name of *canto fermo;* in France by that of *plain chant;* and in Germany and most other countries by that of the *cantus Gregorianus*. Although no satisfactory account has been given of the specific difference between the Ambrosian and Gregorian chants, yet all writers on this subject agree in saying, that St Ambrose only used the four authentic modes, and that the four plagal were afterwards added by St Gregory. Each of these had the same final, or key-note, as its relative authentic; from which there is no other difference, than that the melodies in the four authentic or principal modes are generally confined within the compass of the eight notes above the key-note, and those in the four plagal or relative modes, within the compass of eight notes below the fifth of the key. See MODE

Ecclesiastical writers seem unanimous in allowing that Pope Gregory, who began his pontificate in 590, collected the musical fragments of such ancient psalms and hymns as the first fathers of the church had approved and recommended to the first Christians; and that he selected, methodized, and arranged them in the order which was long continued at Rome, and soon adopted by the chief part of the western church. Gregory is also said to have banished from the church the *canto figurato*, as too light and dissolute; and it is added, that his own chant was called *canto fermo*, from its gravity and simplicity.

It has been long a received opinion, that the ecclesiastical tones were taken from the reformed modes of Ptolemy; but Dr Burney observes, that it is difficult to discover any connection between them, except in their names; for their number, upon examination, is not the same: those of Ptolemy being seven, the ecclesiastical eight; and indeed the Greek names given to the

Service. the ecclesiastical modes do not agree with those of Ptolemy in the single instance of key, but with those of higher antiquity. From the time of Gregory to that of Guido, there was no other distinction of keys than that of authentic and plagal; nor were any semitones used but those from E to F, B to C, and occasionally A to B *b*.

With respect to the music of the primitive church, it may be observed, that though it consisted in the singing of psalms and hymns, yet it was performed in many different ways; sometimes the psalms were sung by one person alone, whilst the rest attended in silence; sometimes they were sung by the whole assembly; sometimes alternately, the congregation being divided into separate choirs; and sometimes by one person, who repeated the first part of the verse, the rest joining in the close of it. Of the four different methods of singing now recited, the second and third were properly distinguished by the names of *symphony* and *antiphony;* and the latter was sometimes called *responsaria*, in which women were allowed to join. St Ignatius, who, according to Socrates (lib. vi. cap. 8.), conversed with the apostles, is generally supposed to have been the first who suggested to the primitive Christians in the East the method of singing hymns and psalms alternately, or in dialogues; and the custom soon prevailed in every place where Christianity was established; though Theodoret in his history (lib. ii. cap. 24.) tells us, that this manner of singing was first practised at Antioch. It likewise appears, that almost from the time when music was first introduced into the service of the church, it was of two kinds, and consisted in a gentle inflection of the voice, which they termed plain song, and a more elaborate and artificial kind of music, adapted to the hymns and solemn offices contained in its ritual; and this distinction has been maintained even to the present day.

Although we find a very early distinction made between the manner of singing the hymns and chanting the psalms, it is, however, the opinion of the learned Martini, that the music of the first five or six ages of the church consisted chiefly in a plain and simple chant of unisons and octaves, of which many fragments are still remaining in the *canto fermo* of the Romish missals. For with respect to music in parts, as it does not appear, in these early ages, that either the Greeks or Romans were in possession of harmony or counterpoint, which has been generally ascribed to Guido, a monk of Arezzo in Tuscany, about the year 1022, though others have traced the origin of it to the eighth century, it is in vain to seek it in the church. The choral music, which had its rise in the church of Antioch, and from thence spread through Greece, Italy, France, Spain, and Germany, was brought into Britain by the singers who accompanied Austin the monk, when be came over, in the year 596, charged with a commission to convert the inhabitants of this country to Christianity. Bede tells us, that when Austin and the companions of his mission had their first audience of King Ethelbert, in the isle of Thanet, they approached him in procession, singing litanies; and that afterwards, when they entered the city of Canterbury, they sung a litany, and at the end of it Allelujah. But though this was the first time the Anglo-Saxons had heard the Gregorian chant, yet Bede likewise tells us, that our British ancestors had been instructed in the rites and ceremonies of the Gallican church by St Germanus, and heard him sing Allelujah many years before the arrival of St Austin. In 680, John, præcentor of St Peter's in Rome, was sent over by Pope Agatho to instruct the monks of Weremouth in the art of singing; and he was prevailed upon to open schools for teaching music in other places in Northumberland. Benedict Biscop, the preceptor of Bede, Adrian the monk, and many others, contributed to disseminate the knowledge of the Roman chant. At length the successors of St Gregory, and of Austin his missionary, having established a school for ecclesiastical music at Canterbury, the rest of the island was furnished with masters from that seminary. The choral service was first introduced in the cathedral church of Canterbury; and till the arrival of Theodore, and his settlement in that see, the practice of it seems to have been confined to the churches of Kent; but after that, it spread over the whole kingdom; and we meet with records of very ample endowments for the support of this part of public worship. This mode of religious worship prevailed in all the European churches till the time of the Reformation: the first deviation from it is that which followed the Reformation by Luther, who, being himself a lover of music, formed a liturgy, which was a musical service, contained in a work entitled *Psalmodia*, h. e. *Cantica sacra Veteris Ecclesiæ selecta*, printed at Norimberg in 1553, and at Wittemberg in 1561. But Calvin, in his establishment of a church at Geneva, reduced the whole of divine service to prayer, preaching, and singing; the latter of which he restrained. He excluded the offices of the antiphon, hymn, and motet, of the Romish service, with that artificial and elaborate music to which they were sung; and adopted only that plain metrical psalmody, which is now in general use among the reformed churches, and in the parochial churches of our own country. For this purpose he made use of Marot's version of the Psalms, and employed a musician to set them to easy tunes only of one part. In 1553, he divided the Psalms into pauses or small portions, and appointed them to be sung in churches. Soon after they were bound up with the Geneva catechism; from which time the Catholics, who had been accustomed to sing them, were forbid the use of them, under a severe penalty. Soon after the Reformation commenced in England, complaints were made by many of the dignified clergy and others of the intricacy and difficulty of the church-music of those times: in consequence of which it was once proposed, that organs and curious singing should be removed from our churches. Latimer, in his diocese of Worcester, went still farther, and issued injunctions to the prior and convent of St Mary, forbidding in their service all manner of singing. In the reign of Edward VI. a commission was granted to eight bishops, eight divines, eight civilians, and eight common lawyers, to compile a body of such ecclesiastical laws as should in future be observed throughout the realm. The result of this compilation was a work first published in 1571 by Fox the martyrologist, and afterwards in 1640, under the title of *Reformatio Legum Ecclesiasticarum.* These 32 commissioners, instead of reprobating church-music, merely condemned figurative and operose music, or that kind of singing which abounded with fugues, responsive passages, and a commixture of various and intricate proportions; which, whether extemporary or written, is by musicians termed *descant*. However,

ever, notwithstanding the objections against choral music, and the practice of some of the reformed churches, the compilers of the English liturgy in 1548, and the king himself, determined to retain musical service. Accordingly the statute 2 & 3 Edw. VI. cap. 1. though it contains no formal obligation on the clergy, or others, to use or join in either vocal or instrumental music in the common prayer, does clearly recognise the practice of singing; and in less than two years after the compiling of King Edward's liturgy, a formula was composed, which continues, with scarce any variation, to be the rule for choral service even at this day. The author of this work was John Marbecke, or Marbeike; and it was printed by Richard Grafton, in 1550 under the title of the Book of Common Prayer, noted. Queen Mary laboured to re-establish the Romish choral service; but the accession of Elizabeth was followed by the act of uniformity; in consequence of which, and of the queen's injunctions, the Book of Common Prayer, noted by Marbecke, was considered as the general formula of choral service. In 1560, another musical service, with some additions and improvements, was printed by John Day; and in 1565, another collection of offices, with musical notes. Many objections were urged by Cartwright and other Puritans against the form and manner of cathedral service, to which Hooker replied in his Ecclesiastical Polity. In 1664, the statutes of Edward VI. and Elizabeth, for uniformity in the Common Prayer, were repealed; and the Directory for Public Worship, which allows only of the singing of psalms, established. But upon the restoration of Charles II. choral service was again revived, and has since uniformly continued. See on this subject Hawkins's History of Music, vol. i. p. 404. vol. ii. p. 264. vol. iii. p. 58—468, &c. vol. iv. p. 44—347.

SERVICE-Tree. See SORBUS, BOTANY *Index*.

SERVITES, a religious order in the church of Rome, founded about the year 1233, by seven Florentine merchants, who, with the approbation of the bishop of Florence, renounced the world, and lived together in a religious community on Mount Senar, two leagues from that city.

SERVITOR, in the university of Oxford, a student who attends on another for his maintenance and learning. See SIZAR.

SERVITUDE, the condition of a servant, or rather slave.

Under the declension of the Roman empire, a new kind of servitude was introduced, different from that of the ancient Romans: it consisted in leaving the lands of subjugated nations to the first owners, upon condition of certain rents, and servile offices, to be paid in acknowledgement. Hence the names of *servi censiti, ascriptitii*, and *addicti glebæ*; some whereof were taxable at the reasonable discretion of the lord; others at a certain rate agreed on; and others were mainmortable, who, having no legitimate children, could not make a will to above the value of five pence, the lord being heir of all the rest; and others were prohibited marrying, or going to live out of the lordship. Most of these services existed lately in France; but they were long ago abolished in England. Such, however, was the original of our tenures, &c. See SLAVE.

SERVITUDE, in *Scots Law*. See LAW, Part III. Sect. ix.

SERVIUS, MAURUS HONORATUS, a celebrated grammarian and critic of antiquity, who flourished about the time of Arcadius and Honorius; now chiefly known by his Commentaries on Virgil. There is also extant a piece of Servius upon the feet of verses and the quantity of syllables, called *Centimetrum*.

SERUM, a thin, transparent, saltish liquor, which makes a considerable part of the mass of blood. See ANATOMY and CHEMISTRY *Index*.

SESAMOIDEA OSSA, certain small bones some what resembling the seeds of sesamum, whence their name. They are placed at the under part of the bones of the last joints of the fingers and toes.

SESAMUM, OILY GRAIN; a genus of plants belonging to the class didynamia; and in the natural system ranging under the 20th order, *Luridæ*. See BOTANY *Index*.

SESELI, MEADOW SAXIFRAGE; a genus of plants belonging to the class pentandria; and in the natural system ranging under the 45th order, *Umbellatæ*. See BOTANY *Index*.

SESOSTRIS, king of Egypt. See EGYPT, p. 591.

SESQUI, a Latin particle, signifying a whole and a half; which, joined with *altera, terza, quarta*, &c. is much used in the Italian music to express a kind of ratios, particularly several species of triples.

SESQUI-Alterate, in *Geometry* and *Arithmetic*, is a ratio between two lines, two numbers, or the like, where one of them contains the other once, with the addition of a half.

Thus 6 and 9 are in a sesqui-alterate ratio; since 9 contains 6 once, and 3, which is half of 6, over; and 20 and 30 are in the same; as 30 contains 20, and half 20 or 10.

SESQUI-Duplicate ratio, is when of two terms the greater contains the less twice, and half the less remains; as 15 and 6; 50 and 20.

SESQUI-Tertional proportion, is when any number or quantity contains another once and one third.

SESSILE, among botanists. See BOTANY.

SESSION, in general, denotes each sitting or assembly of a council, &c.

SESSION of Parliament, is the season or space from its meeting to its prorogation. See PARLIAMENT.

Kirk-SESSION, the name of a petty ecclesiastical court in Scotland. See *KIRK-Session*.

SESSIONS for weights and measures. In London, four justices from among the mayor, recorder, and aldermen (of whom the mayor and recorder is to be one), may hold a session to inquire into the offences of selling by false weights and measures, contrary to the statutes; and to receive indictments, punish offenders, &c. Char. King Charles I.

Court of SESSION. See LAW, Part III. Sect ii.

Court of Quarter-SESSIONS, an English court that must be held in every county once in every quarter of a year; which, by statute 2 Henry V. c. 4. is appointed to be in the first week after Michaelmas-day, the first week after the epiphany, the first week after the close of Easter, and in the week after the translation of St Thomas the martyr, or the 7th of July. It is held before two or more justices of the peace, one of which must be of the quorum. The jurisdiction of this court, by 34 Edward III. c. 1. extends to the trying and determining all felonies and trespasses whatsoever: though they seldom,

dom, if ever, try any greater offence than fmall felonies within the benefit of clergy; their commiffion providing, that if any cafe of difficulty arifes, they fhall not proceed to judgement, but in the prefence of one of the juftices of the courts of king's bench or common-pleas, or one of the judges of affize: and therefore murders, and other capital felonies, are ufually remitted for a more folemn trial to the affizes. They cannot alfo try any new-created offence, without exprefs power given them by the ftatute which creates it. But there are many offences and particular matters which, by particular ftatutes, belong properly to this jurifdiction, and ought to be profecuted in this court; as, the fmaller mifdemeanors againft the public or commonwealth, not amounting to felony; and efpecially offences relating to the game, highways, alehoufes, baftard children, the fettlement and provifion for the poor, vagrants, fervants wages, and Popifh recufants. Some of thefe are proceeded upon by indictment: others in a fummary way, by motion, and order thereupon; which order may for the moft part, unlefs guarded againft by particular ftatutes, be removed into the court of king's-bench by writ of *certiorari facias*, and be there either quafhed or confirmed. The records or rolls of the feffions are committed to the cuftody of a fpecial officer, denominated *cuftos rotulorum*, who is always a juftice of the quorum; and among them of the quorum (faith Lambard) a man for the moft part efpecially picked out, either for wifdom, countenance, or credit. The nomination of the *cuftos rotulorum* (who is the principal officer in the county, as the lord-lieutenant is chief in military command) is by the king's fign manual: and to him the nomination of the clerk of the peace belongs; which office he is exprefsly forbidden to fell for money.

In moft corporation-towns there are quarter-feffions kept before juftices of their own, within their refpective limits; which have exactly the fame authority as the general quarter-feffions of the county, except in a very few inftances; one of the moft confiderable of which is the matter of appeals from orders of removal of the poor, which, though they be from the orders of corporation-juftices, muft be to the feffions of the county, by ftatute 8 and 9 William III. c. 30. In both corporations and counties at large, there is fometimes kept a fpecial or petty feffion, by a few juftices, for difpatching fmaller bufinefs in the neighbourhood between the times of the general feffions; as for licenfing alehoufes, paffing the account of parifh-officers, and the like.

SESTERCE, SESTERTIUS, a filver coin, in ufe among the ancient Romans, called alfo fimply *nummus*, and fometimes *nummus feftertius*. The feftertius was the fourth part of the denarius, and originally contained two affes and a half. It was at firft denoted by LLS; the two L's fignifying two libræ, and the S half. But the librarii, afterwards converting the two L's into an H, expreffed the feftertius by HS. The word *feftertius* was firft introduced by way of abbreviation for *femiftertius*, which fignifies two, and a half of a third, or, literally, only half a third; for in expreffing half a third, it was underftood that there were two before.

Some authors make two kinds of fefterces; the lefs called *feftertius*, in the mafculine gender; and the great one, called *feftertium*, in the neuter: the firft, that we have already defcribed; the latter containing a thoufand of the other. Others will have any fuch diftinction of great and little fefterces unknown to the Romans: *feftertius*, fay they, was an adjective, and fignified *as feftertius*, or two affes and a half; and when ufed in the plural, as in *quinquaginta feftertium*, or *feftertia*, it was only by way of abbreviation, and there was always underftood *centena, millia*, &c.

This matter has been accurately ftated by Mr Raper, in the following manner. The fubftantive to which feftertius referred is either *as*, or *pondus*; and *feftertius as* is two affes and a half; *feftertium pondus*, two pondera and a half, or two hundred and fifty denarii. When the denarius paffed for ten affes, the feftertius of two affes and a half was a quarter of it; and the Romans continued to keep their accounts in thefe fefterces long after the denarius paffed for fixteen affes; till, growing rich, they found it more convenient to reckon by quarters of the denarius, which they called *nummi*, and ufed the words *nummus* and *feftertius* indifferently, as fynonymous terms, and fometimes both together, as *feftertius nummus*; in which cafe the word *feftertius*, having loft its original fignification, was ufed as a fubftantive; for *feftertius nummus* was not two nummi and a half, but a fingle nummus of four affes. They called any fum under two thoufand fefterces fo many *feftertii* in the mafculine gender; two thoufand fefterces they called *duo* or *bina feftertia*, in the neuter; fo many quarters making five hundred denarii, which was twice the feftertium; and they faid *dena, vicena*, &c. *feftertia*, till the fum amounted to a thoufand feftertia, which was a million of fefterces. But, to avoid ambiguity, they did not ufe the neuter *feftertium* in the fingular number, when the whole fum amounted to no more than a thoufand fefterces, or one feftertium. They called a million of fefterces *decies nummûm*, or *decies feftertiûm*, for *decies centena millia nummorum*, or *feftertiorum* (in the mafculine gender), omitting *centena millia* for the fake of brevity. They likewife called the fame fum *decies feftertium* (in the neuter gender) for *decies centies feftertium*, omitting *centies* for the fame reafon; or fimply *decies*, omitting *centena millia feftertiûm*, or *centies feftertium*; and with the numeral adverbs *decies, vicies, centies, millies*, and the like, either *centena millia* or *centies* was always underftood. Thefe were their moft ufual forms of expreffion; though for *bina, dena, vicena feftertia*, they frequently faid *bina, dena, vicena millia nummûm*. If the confular denarius contained 60 troy grains of fine filver, it was worth fomewhat more than eight-pence farthing and a half fterling; and the as, of 16 to the denarius, a little more than a half-penny. To reduce the ancient fefterces of two affes and a half, when the denarius paffed for 16, to pounds fterling, multiply the given number by 5454, and cut off fix figures on the right hand for decimals. To reduce *nummi feftertii*, or quarters of the denarius, to pounds fterling; if the given fum be confular money, multiply it by 8727, and cut off fix figures on the right hand for decimals; but for imperial money diminifh the faid product by one-eighth of itfelf. Phil. Tranf. vol. lxi. part ii. art. 48.

To be qualified for a Roman knight, an eftate of 400,000 *fefterces* was required; and for a fenator, of 800,000.

Authors alfo mention a copper *fefterce*, worth about one-third of a penny Englifh.

SESTERCE, or *feftertius*, was alfo ufed by the ancients for a thing containing two wholes and an half of another, as *as* was taken for any whole or integer.

SESTOS, a noted fortrefs of European Turkey, fituated at the entrance of the Hellefpont or Dardanelles, 24 miles fouth-weft of Gallipoli. This place is famous for the loves of HERO and LEANDER, fung by the poet Mufæus.

SESUVIUM, a genus of plants belonging to the clafs icofandria. See BOTANY *Index*.

SET, or SETS, a term ufed by the farmers and gardeners to exprefs the young plants of the white thorn and other fhrubs, with which they ufe to raife their quick or quick-fet hedges. The white thorn is the beft of all trees for this purpofe; and, under proper regulations, its fets feldom fail of anfwering the farmer's utmoft expectations.

SET-off, in *Law*, is an act whereby the defendant acknowledges the juftice of the plaintiff's demand on the one hand; but, on the other, fets up a demand of his own, to counterbalance that of the plaintiff, either in the whole, or in part: as, if the plaintiff fues for 10l. due on a note of hand, the defendant may fet off 9l. due to himfelf for merchandife fold to the plaintiff; and, in cafe he pleads fuch fet-off, muft pay the remaining balance into court. This anfwers very nearly to the *compenfatio* or ftoppage of the civil law, and depends upon the ftatutes 2 Geo. II. cap. 22. and 8 Geo. II. cap. 24.

SETACEOUS WORM, in *Natural Hiftory*, a name given by Dr Lifter to that long and flender waterworm, which fo much refembles a horfe-hair, that it has been fuppofed by the vulgar to be an animated hair of that creature. Thefe creatures, fuppofed to be living hairs, are a peculiar fort of infects, which are bred and nourifhed within the bodies of other infects, as the worms of the ichneumon flies are in the bodies of the caterpillars.

Aldrovand defcribes the creature, and tells us it was unknown to the ancients; but called *feta aquatica*, and *vermis fetarius*, by the moderns, either from its figure refembling that of a hair, or from the fuppofition of its once having been the hair of fome animal. We generally fuppofe it, in the imaginary ftate of the hair, to have belonged to a horfe; but the Germans fay it was once the hair of a calf, and call it by a name fignifying *vitulus aquaticus*, or the "water calf."

Albertus, an author much reverenced by the common people, has declared that this animal is generated of a hair; and adds, that any hair thrown into ftanding water, will, in a very little time, obtain life and motion. Other authors have diffented from this opinion, and fuppofed them generated of the fibrous roots of waterplants; and others, of the parts of grafshoppers fallen into the water. This laft opinion is rejected by Aldrovand as the moft improbable of all. Standing and foul waters are moft plentifully ftored with them; but they are fometimes found in the cleareft and pureft fprings, and fometimes out of the water, on the leaves of trees and plants, as on the fruit-trees in our gardens, and the elms in hedges. They are from three to five inches long, of the thicknefs of a large hair; and are brown upon the back, and white under the belly, and the tail is white on every part.

SETH, the third fon of Adam, the father of Enos, was born 3874 B. C. and lived 912 years.

SETHIANS, in church hiftory, Chriftian heretics; fo called becaufe they paid divine worfhip to Seth, whom they looked upon to be Jefus Chrift the fon of God, but who was made by a third divinity, and fubftituted in the room of the two families of Abel and Cain, which had been deftroyed by the deluge. Thefe heretics appeared in Egypt in the fecond century; and as they were addicted to all forts of debauchery, they did not want followers; and continued in Egypt above 200 years.

SETIMO, a town of Italy, in the province of Piedmont, fituated on the river Po, eight miles north of Turin.

SETON, in *Surgery*, a few horfe hairs, fmall threads, or large packthread, drawn through the fkin, chiefly the neck, by means of a large needle or probe, with a view to reftore or preferve health.

Experience fhews that fetons are ufeful in catarrhs, inflammations, and other diforders, and particularly thofe of the eyes; to thefe may be added fevere headachs, with ftupor, drowfinefs, epilepfies, and even apoplexy itfelf. See SURGERY.

SETTEE, in fea-language, a veffel very common in the Mediterranean with one deck and a very long and fharp prow. They carry fome two mafts, fome three, without top-mafts. They have generally two mafts, equipped with triangular fails, commonly called *lateen fails*. The leaft of them are of 60 tons burden. They ferve to tranfport cannon and provifions for fhips of war and the like. Thefe veffels are peculiar to the Mediterranean fea, and are ufually navigated by Italians, Greeks, or Mahometans.

SETTING, in *Aftronomy*, the withdrawing of a ftar or planet, or its finking below the horizon. Aftronomers and poets make three different kinds of fetting of the ftars, viz. the COSMICAL, ACRONYCAL, and HELIACAL. See thefe articles.

SETTING, in the fea language. To fet the land or the fun by the compafs, is to obferve how the land bears on any point of the compafs, or on what point of the compafs the fun is. Alfo when two fhips fail in fight of one another, to mark on what point the chafed bears, is termed *fetting the chace by the compafs*.

SETTING, among fportfmen, a term ufed to exprefs the manner of taking partridges by means of a dog peculiarly trained to that purpofe. See SHOOTING.

ACT OF SETTLEMENT, in Britifh hiftory, a name given to the ftatute 12 and 13 Will. III. cap. 2. whereby the crown was limited to his prefent majefty's illuftrious houfe; and fome new provifions were added, at the fame fortunate era, for better fecuring our religion, laws, and liberties: which the ftatute declares to be the birthright of the people of England, according to the ancient doctrine of the common law.

SEVEN STARS, a common denomination given to the clufter of ftars in the neck of the fign Taurus, the bull; properly called the *Pleiades*. They are fo called from their number feven, which appear to the naked eye, though fome eyes can difcover only fix of them; but by the aid of telefcopes there appears to be a great multitude of them.

SEVENTH, in *Mufic*, an interval called by the Greeks *heptachordon*. See INTERVAL.

SEVERANCE, in *Law*, the fingling or fevering two or more that join or are joined in the fame writ or action.

Severance ‖ Severn.

tion. As if two join in a writ, *de libertate probanda*, and the one be afterwards nonsuited; here severance is permitted, so as notwithstanding the nonsuit of the one, the other may severally proceed.

There is also severance of the tenants in assize; when one, two, or more disseisees appear upon the writ, and not the other. And severance in debt, where two executors are named plaintiffs, and the one refuses to prosecute. We also meet with severance of summons, severance in attaints, &c. An estate in joint tenancy may be severed and destroyed by destroying any of its unities. 1. That of time, which respects only the original commencement of the joint estate, cannot indeed (being now part) be affected by any subsequent transaction. But, 2. The joint-tenants estate may be destroyed without any alienation, by merely disuniting their possession. 3. The jointure may be destroyed, by destroying the unity of title. And, 4. By destroying the unity of interest.

SEVERIA, a province of the Russian empire, with the title of a duchy, bounded on the north by Smolensko and Muscovy, on the east by Vorotinsbi and the country of the Cossacks, on the south by the same, and on the west by Zernegovia. It is a country overrun with woods, and on the south part is a forest of great length. Novogrodec, or Novogorod, is the capital town.

St SEVERINA, a town of Italy, in the kingdom of Naples, and in Lower Calabria, with an archbishop's see. It is very well fortified, and seated on a craggy rock, on the river Neeto; in E. Long. 17. 14. N. Lat. 39. 15.

SEVERINO, a town of Italy, in the territory of the church, and in the Marche of Ancona, with a bishop's see. It has fine vineyards, and is seated between two hills on the river Petenza, in E. Long. 13. 6. N. Lat. 43. 16.

SEVERN, a river of England which rises near Plimlimmon Hill in Montgomeryshire, and before it enters Shropshire receives about 30 streams, and passes down to Laudring, where it receives the Morda, that flows from Oswestry. When it arrives at Monford, it receives the river Mon, passing on to Shrewsbury, which it almost surrounds, then to Bridgeworth; afterwards it runs through the skirts of Staffordshire, enters Worcestershire, and passes by Worcester; then it runs to Tewkesbury, where it joins the Avon, and from thence to Gloucester, keeping a north-westerly course, till it falls into the Bristol Channel. It begins to be navigable for boats at Welchpool, in Montgomeryshire, and takes in several other rivers in its course, besides those already mentioned, and *is the second in England*. By the late inland navigation, it has communication with the rivers Mersey, Dee, Ribble, Ouse, Trent, Derwent, Humber, Thames, Avon, &c. which navigation, including its windings, extends above 500 miles in the counties of Lincoln, Nottingham, York, Lancaster, Westmoreland, Chester, Stafford, Warwick, Leicester, Oxford, Worcester, &c. A canal from Stroud-Water, a branch of the Severn, to join the Thames, was projected and executed for the purpose of conveying a tunnel 16 feet high and 16 feet wide, under Sapperton Hill and Hayley-Wood (very high ground), for two miles and a quarter in length, through a very hard rock, which was lined and arched with brick. This stupendous undertaking was completed, and boats passed through it the

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21st of May 1789. By this opening, a communication is made between the river Severn at Framiload and the Thames near Lechlade, and will be continued over the Thames near Inglesham, into deep water in the Thames below St John-Bridge, and so to Oxford, &c. and London, for conveyance of coals, goods, &c. It is now navigable from the Severn to Themsford, by way of Stroud, Cirencester, Cricklade, &c. being filled with water for that purpose near 40 miles.

Severn, Severus.

SEVERUS, Cornelius, an ancient Latin poet of the Augustan age; whose *Ætna*, together with a fragment *De morte Ciceronis*, were published, with notes and a prose interpretation, by Le Clerc, 12mo, Amsterdam, 1703. They were before inserted among the *Catalecta Virgilii* published by Scaliger; whose notes, with others, Le Clerc has received among his own.

Severus, *Septimus*, a Roman emperor, who has been so much admired for his military talents, that some have called him the most warlike of the Roman emperors. As a monarch he was cruel, and it has been observed that he never did an act of humanity or forgave a fault. In his diet he was temperate, and he always showed himself an open enemy to pomp and splendor. He loved the appellation of a man of letters, and he even composed an history of his own reign, which some have praised for its correctness and veracity. However cruel Severus may appear in his punishments and in his revenge, many have endeavoured to exculpate him, and observed that there was need of severity in an empire where the morals were so corrupted, and where no less than 3000 persons were accused of adultery during the space of 17 years. Of him, as of Augustus, some were disposed to say, that it would have been better for the world if he had never been born, or had never died. See Rome, N° 372.

Severus's Wall, in British topography, the fourth and last barrier erected by the Romans against the incursions of the North Britons. See the articles Adrian, and *Antoninus's Wall*.

We learn from several hints in the Roman historians, that the country between the walls of Hadrian and Antoninus continued to be a scene of perpetual war and subject of contention between the Romans and Britons, from the beginning of the reign of Commodus to the arrival of the emperor Septimius Severus in Britain, A.D. 206. This last emperor having subdued the Mæatæ, and repulsed the Caledonians, determined to erect a stronger and more impenetrable barrier than any of the former, against their future incursions.

Though neither Dio nor Herodian make any mention of a wall built by Severus in Britain for the protection of the Roman province, yet we have abundant evidence from other writers of equal authority, that he really built such a wall. "He fortified Britain (says Spartian) with a wall drawn cross the island from sea to sea; which is the greatest glory of his reign. After the wall was finished, he retired to the next station (York), not only a conqueror, but the founder of an eternal peace." To the same purpose, Aurelius Victor and Orosius, to say nothing of Eutropius and Cassiodorus: "Having repelled the enemy in Britain, he fortified the country, which was suited to that purpose, with a wall drawn cross the island from sea to sea."—"Severus drew a great ditch, and built a strong wall, fortified

fortified with several turrets, from sea to sea, to protect that part of the island which he had recovered from the yet unconquered nations." As the residence of the emperor Severus in Britain was not quite four years, it is probable that the two last of them were employed in building this wall; according to which account, it was begun A. D. 209, and finished A. D. 211.

This wall of Severus was built nearly on the same tract with Hadrian's rampart, at the distance only of a few paces north. The length of this wall, from Cousin's house near the mouth of the river Tyne on the east, to Boulness on the Solway frith on the west, hath been found, from two actual mensurations, to be a little more than 68 English miles, and a little less than 74 Roman miles. To the north of the wall was a broad and deep ditch, the original dimensions of which cannot now be ascertained, only it seems to have been larger than that of Hadrian. The wall itself, which stood on the south brink of the ditch, was built of freestone, and where the foundation was not good, it is built on piles of oak; the interstices between the two faces of this wall is filled with broad thin stones, placed not perpendicularly, but obliquely on their edges; the running mortar or cement was then poured upon them, which, by its great strength and tenacity, bound the whole together, and made it firm as a rock. But though these materials are sufficiently known, it is not easy to guess where they were procured, for many parts of the wall are at a great distance from any quarry of freestone; and, though stone of another kind was within reach, yet it does not appear to have been anywhere used. The height of this wall was 12 feet besides the parapet, and its breadth 8 feet, according to Bede, who lived only at a small distance from the east end of it, and in whose time it was in many places almost quite entire. Such was the wall erected by the command and under the direction of the emperor Severus in the north of England; and, considering the length, breadth, height, and solidity, it was certainly a work of great magnificence and prodigious labour. But the wall itself was but a part, and not the most extraordinary part, of this work. The great number and different kinds of fortresses which were built along the line of it for its defence, and the military ways with which it was attended, are still more worthy of our admiration, and come now to be described.

The fortresses which were erected along the line of Severus's wall for its defence, were of three different kinds, and three different degrees of strength; and were called by three different Latin words, which may be translated *stations*, *castles*, and *turrets*. Of each of these in their order.

The *stationes*, stations, were so called from their stability and the stated residence of garrisons. They were also called *castra*, which hath been converted into *chesters*, a name which many of them still bear. These were by far the largest, strongest, and most magnificent of the fortresses which were built upon the wall, and were designed for the head-quarters of the cohorts of troops which were placed there in garrison, and from whence detachments were sent into the adjoining castles and turrets. These stations, as appears from the vestiges of them which are still visible, were not all exactly of the same figure nor of the same dimensions; some of them being exactly squares, and others oblong, and some of them a little larger than others. These variations were no doubt occasioned by the difference of situation and other circumstances. The stations were fortified with deep ditches and strong walls, the wall itself coinciding with and forming the north wall of each station. Within the stations were lodgings for the officers and soldiers in garrison; the smallest of them being sufficient to contain a cohort, or 600 men. Without the walls of each station was a town, inhabited by labourers, artificers, and others, both Romans and Britons, who chose to dwell under the protection of these fortresses. The number of the stations upon the wall was exactly 18; and if they had been placed at equal distances, the interval between every two of them would have been four miles and a few paces: but the intervention of rivers, marshes, and mountains; the conveniency of situations for strength, prospect, and water; and many other circumstances to us unknown, determined them to place these stations at unequal distances. The situation which was always chosen by the Romans, both here and everywhere else in Britain where they could obtain it, was the gentle declivity of a hill, near a river, and facing the meridian sun. Such was the situation of the far greatest part of the stations on this wall. In general, we may observe, that the stations stood thickest near the two ends and in the middle, probably because the danger of invasion was greatest in these places. But the reader will form a clearer idea of the number of these stations, their Latin and English names, their situation and distance from one another, by inspecting the following table, than we can give him with equal brevity in any other way. The first column contains the number of the station, reckoning from east to west; the second contains its Latin, and the third its English name; and the three last its distance from the next station to the west of it, in miles, furlongs, and chains.

N°	Latin Name.	English Name.	M.	F.	C.
1	Segedunum	Cousin's-house	3	5	1½
2	Pons Ælii	Newcastle	2	0	9
3	Condercum	Benwell hill	6	6	5
4	Vindobala	Rutchester	7	0	3½
5	Hunnum	Halton-chesters	5	1	7
6	Cilurnum	Walwick-chesters	3	1	8
7	Procolitia	Carrawbrugh	4	5	3½
8	Borcovicus	Housesteeds	1	3	8
9	Vindolana	Little-chesters	3	6	4
10	Æsica	Great-chesters	2	1	6½
11	Magna	Carrvoran	2	6	0
12	Amboglana	Burdoswald	6	2	8
13	Petriana	Cambeck	2	6	6
14	Aballaba	Watchcross	5	1	9
15	Congavata	Stanwix	3	3	4
16	Axelodunum	Brugh	4	0	9
17	Gabrosentum	Brumbrugh	3	4	1
18	Tunnocelum	Boulness	0	0	0
		Length of the wall	68	3	3

The *castella*, or castles, were the second kind of fortifications which were built along the line of this wall for its defence. These castles were neither so large nor strong

Severus. ſtrong as the ſtations, but much more numerous, being no fewer than 81. The ſhape and dimenſions of the caſtles, as appears from the foundations of many of them which are ſtill viſible, were exact ſquares of 66 feet every way. They were fortified on every ſide with thick and lofty walls, but without any ditch, except on the north ſide; on which the wall itſelf, raiſed much above its uſual height, with the ditch attending it, formed the fortification. The caſtles were ſituated in the intervals between the ſtations, at the diſtance of about ſeven furlongs from each other; though particular circumſtances ſometimes occaſioned a little variation. In theſe caſtles, guards were conſtantly kept by a competent number of men detached from the neareſt ſtations.

The *turres*, or turrets, were the third and laſt kind of fortifications on the wall. Theſe were ſtill much ſmaller than the caſtles, and formed only a ſquare of about 12 feet, ſtanding out of the wall on its ſouth ſide. Being ſo ſmall, they are more entirely ruined than the ſtations and caſtles, which makes it difficult to diſcover their exact number. They ſtood in the intervals between the caſtles; and from the faint veſtiges of a few of them, it is conjectured that there were four of them between every two caſtles, at the diſtance of about 300 yards from one another. According to this conjecture, the number of the turrets amounted to 324. They were deſigned for watch-towers and places for ſentinels, who, being within hearing of one another, could convey an alarm or piece of intelligence to all parts of the wall in a very little time.

Such were the ſtations, caſtles, and turrets, on the wall of Severus; and a very conſiderable body of troops was conſtantly quartered in them for its defence. The uſual complement allowed for this ſervice was as follows:

1. Twelve cohorts of foot, conſiſting of 600 men each, - - -	7200
2. One cohort of mariners in the ſtation at Boulneſs, - - - - -	600
3. One detachment of Moors, probably equal to a cohort, - - -	600
4. Four alæ or wings of horſe, conſiſting, at the loweſt computation, of 400 each, -	1600
	10,000

For the conveniency of marching theſe troops from one part of the wall to another, with the greater eaſe and expedition, on any ſervice, it was attended with two military ways, paved with ſquare ſtones, in the moſt ſolid and beautiful manner. One of theſe ways was ſmaller, and the other larger. The ſmaller military way run cloſe along the ſouth ſide of the wall, from turret to turret, and caſtle to caſtle, for the uſe of the ſoldiers in relieving their guards and centinels, and ſuch ſervices. The larger way did not keep ſo near the wall, nor touch at the turrets or caſtles, but purſued the moſt direct courſe from one ſtation to another, and was deſigned for the conveniency of marching larger bodies of troops.

It is to be regretted, that we cannot gratify the reader's curioſity, by informing him by what particular bodies of Roman troops the ſeveral parts of this great work were executed; as we were enabled to do with regard to the wall of Antoninus Pius from inſcriptions. For though it is probable that there were ſtones with inſcriptions of the ſame kind, mentioning the ſeveral bodies of troops, and the quantity of work performed by each of them, originally inſerted in the face of this wall, yet none of them are now to be found. There have indeed been diſcovered, in or near the ruins of this wall, a great number of ſmall ſquare ſtones, with very ſhort, and generally imperfect, inſcriptions upon them; mentioning particular legions, cohorts, and centuries; but without directly aſſerting that they had built any part of the wall, or naming any number of paces. Of theſe inſcriptions, the reader may ſee no fewer than twenty-nine among the Northumberland and Cumberland inſcriptions in Mr Horſley's Britannia Romana. As the ſtones on which theſe inſcriptions are cut are of the ſame ſhape and ſize with the other facing-ſtones of this wall, it is almoſt certain that they have been originally placed in the face of it. It is equally certain, from the uniformity of theſe inſcriptions, that they were all intended to intimate ſome one thing, and nothing ſo probable as that the adjacent wall was built by the troops mentioned in them. This was, perhaps, ſo well underſtood, that it was not thought neceſſary to be expreſſed; and the diſtance of theſe inſcriptions from one another ſhowed the quantity of work performed. If this was really the caſe, we know in general, that this great work was executed by the ſecond and ſixth legions, theſe being the only legions mentioned in theſe inſcriptions. Now, if this prodigious wall, with all its appendages of ditches, ſtations, caſtles, turrets, and military ways, was executed in the ſpace of two years by two legions only, which, when moſt complete, made no more than 12,000 men, how greatly muſt we admire the ſkill, the induſtry, and excellent diſcipline of the Roman ſoldiers, who were not only the valiant guardians of the empire in times of war, but its moſt active and uſeful members in times of peace?

This wall of Severus, and its fortreſſes, proved an impenetrable barrier to the Roman territories for near 200 years. But about the beginning of the 5th century, the Roman empire being aſſaulted on all ſides, and the bulk of their forces withdrawn from Britain, the Mæatæ and Caledonians, now called *Scots* and *Picts*, became more daring; and ſome of them breaking through the wall, and others ſailing round the ends of it, they carried their ravages into the very heart of Provincial Britain. Theſe invaders were indeed ſeveral times repulſed after this by the Roman legions ſent to the relief of the Britons. The laſt of theſe legions, under the command of Gallio of Ravenna, having, with the aſſiſtance of the Britons, thoroughly repaired the breaches of Severus's wall and its fortreſſes, and exhorted the Britons to make a brave defence, took their final farewell of Britain. It ſoon appeared, that the ſtrongeſt walls and ramparts are no ſecurity to an undiſciplined and daſtardly rabble, as the unhappy Britons then were. The Scots and Picts met with little reſiſtance in breaking through the wall, while the towns and caſtles were tamely abandoned to their deſtructive rage. In many places they levelled it with the ground, that it might prove no obſtruction to their future inroads.—From this time no attempts were ever made to repair this noble work. Its beauty and grandeur procured it no reſpect in the dark and taſteleſs ages which ſucceeded. It became

Sevigné. came the common quarry for more than a thousand years, out of which all the towns and villages around were built; and is now so entirely ruined, that the penetrating eyes of the most poring and patient antiquarian can hardly trace its vanishing foundations.

SEVIGNE', Marie de Rabutin, Marquise de, a French lady, was born in 1626. When only a year old she lost her father, who was killed in the descent of the English on the isle of Rhé, where he commanded a company of volunteers. In 1644 she married the marquis of Sevigné, who was slain in a duel by the chevalier d'Albret, in 1651. She had by him a son and a daughter, to the education of whom she afterwards religiously devoted herself. Her daughter was married in 1669 to the count of Grignan, who conducted her to Provence. Madame de Sevigné consoled herself by writing frequent letters to her daughter. She fell at last the victim to her maternal tenderness. In one of her visits to Grignan, she fatigued herself so much during the sickness of her daughter, that she was seized with a fever, which carried her off on the 14th of January 1696. We have two portraits of Madame de Sevigné; the one by the compte de Bussi, the other by Madame de la Fayette. The first exhibits her defects; the second her excellencies. Bussi describes her as a lively gay coquette, a lover of flattery, fond of titles, honour, and distinction: M. de la Fayette as a woman of wit and good sense, as possessed of a noble soul, formed for dispensing benefits, incapable of debasing herself by avarice, and blessed with a generous, obliging, and faithful heart. Both these portraits are in some measure just. That she was vain-glorious, appears evident from her own letters, which, on the other hand, exhibit undoubted proofs of her virtue and goodness of heart.

This illustrious lady was acquainted with all the wits of her age. It is said that she decided the famous dispute between Perrault and Boileau concerning the preference of the ancients to the moderns, thus, "The ancients are the finest, and we are the prettiest." She left behind her a most valuable collection of letters, the best edition of which is that of 1775, in 8 vols 12mo. "These letters (says Voltaire) are filled with anecdotes, written with freedom, and in a natural and animated style; are an excellent criticism on studied letters of wit, and still more on those fictitious letters which aim at the epistolary style, by a recital of false sentiments and feigned adventures to an imaginary correspondent." It were to be wished that a proper selection had been made of these letters. It is difficult to read eight volumes of letters, which, though inimitably written, present frequent repetitions, and are often filled with trifles. What makes them in general perhaps so interesting is, that they are in part historical. They may be looked on as a relation of the manners, the ton, the genius, the fashions, the etiquette, which reigned in the court of Louis XIV. They contain many curious anecdotes nowhere else to be found: But these excellencies would be still more striking, were they sometimes stripped of that multitude of domestic affairs and minute incidents which ought naturally to have died with the mother and the daughter. A volume entitled *Sevigniana* was published at Paris in 1756, which is nothing more than a collection of the fine sentiments, literary and historical anecdotes, and moral apophthegms, scattered throughout these letters.

Siecle de Louis XIV. tom. ii.

Seville.

SEVILLE, a large and populous city of Spain, stands on the banks of the Guadalquiver, in the midst of a rich, and to the eye a boundless, plain; in W. Long. 5° 5′, N. Lat. 37° 20′. This city is supposed to have been founded by the Phœnicians, who gave it the name of *Hispalis*. When it fell under the power of the Romans, it was called *Julia*; and at last, after a variety of corruptions, was called *Sebilla* or *Sevilla*; both of which names are retained by the Spaniards. The Romans embellished it with many magnificent edifices; of which scarce any vestige now remains. The Gothic kings for some time made it their residence: but in process of time they removed their court to Toledo; and Seville was taken by storm soon after the victory obtained at Xeres over the Gothic king Rodrigo.—In 1027, Seville became an independent monarchy; but was conquered 70 years afterwards by Yusef Almoravides, an African prince. At last it was taken by Ferdinand III. after a year's siege; and 300,000 Moors were then obliged to leave the place. Notwithstanding this prodigious emigration, Seville continued to be a great and populous city, and soon after it was enlarged and adorned with many magnificent buildings, the chief of which is the cathedral. Seville arrived at its utmost pitch of grandeur a little after the discovery of America, the reason of which was, that all the valuable productions of the West Indies were carried thither. Its court was then the most splendid in Europe; but in the course of a few years all this grandeur disappeared, owing to the impediments in navigating the Guadalquiver. The superior excellence of the port of Cadiz induced government to order the galeons to be stationed there in time to come.

Seville is of a circular form, and is surrounded by a wall about five miles and a half in circumference, containing 176 towers. The ditch in many places is filled up. The streets of Seville are crooked and dirty, and most of them so narrow that two carriages can scarcely pass one another abreast.

Seville is said to contain 80,268 souls, and is divided into 30 parishes. It has 84 convents, with 24 hospitals.

Of the public edifices of this city the cathedral is the most magnificent. Its dimensions are 420 feet in length, 263 in breadth within the walls, and 126 feet in height. It has nine doors, 80 altars, at which 500 masses are daily celebrated, and 80 windows of painted glass, each of which cost 1000 ducats. At one angle stands a tower of Moorish workmanship 350 feet high. On the top of it is the giralda, or large brazen image, which, with its palm branch, weighs near one ton and a half, yet turns as a weather-cock with the slightest variation of the wind. The whole work is brick and mortar. The passage to the top is an inclined plane, which winds about in the inside in the manner of a spiral staircase, so easy of ascent that a horse might trot from the bottom to the top; at the same time it is so wide that two horsemen may ride abreast. What appears very unaccountable, the solid masonry in the upper half is just as thick again as that in the lower, though on the outside the tower is all the way of the same dimensions. In the opinion of Mr Swinburne, this cathedral is inferior to York-

Townsend's Travels, vol. ii.

Seville. York minster. Its treasures are inestimable; one altar with all its ornaments is solid silver; of the same metal are the images of St Isidore and St Leander, which are as large as the life; and a tabernacle for the host more than four yards high, adorned with 48 columns. Before the choir of the cathedral is the tomb of the celebrated Christopher Columbus, the discoverer of America. His monument consists of one stone only, on which these words are inscribed, *A Castella y Arragon otro mundo dio Colon;* that is, "To Castile and Arragon Columbus gave another world:" an inscription simple and expressive, the justness of which will be acknowledged by those who have read the adventures of this illustrious but unfortunate man. The cathedral was begun by Don Sancho the Brave, about the close of the 13th century, and finished by John II. about an hundred years after. To the cathedral belongs a library of 20,000 volumes, collected by Hernando the son of Columbus; but, to the disgrace of the Spaniards, it has scarcely received any addition since the death of the founder. The organ in this cathedral is a very ingenious piece of mechanism †. "I was much pleased (says Mr Townsend in his interesting travels) with the construction of a new organ, containing 5300 pipes, with 110 stops, which latter, as the builder told me, is 50 more than are in the famous one of Haerlem; yet, so ample are the bellows, that when stretched they supply the full organ 15 minutes. The mode of filling them with air is singular; for, instead of working with his hands, a man walks backwards and forwards along an inclined plane of about 15 feet in length, which is balanced in the middle on its axis; under each end is a pair of bellows, of about six feet by three and a half. These communicate with five other pairs united by a bar; and the latter are so contrived, that when they are in danger of being overstrained, a valve is lifted up, and gives them relief. Passing 10 times along the inclined plane fills all these vessels."

Bourgoanne's Travels, vol. ii.

† Vol. ii. p. 318.

The Canos de Carmone, or great aqueduct of Seville, is reckoned by the historians of this city one of the most wonderful works of antiquity. Mr Swinburne, however, remarks, that it is ugly, crooked, the arches unequal, and the architecture neglected. The conduit is so leaky, that a rivulet is formed by the waste water. Nevertheless, it still conveys to the city an ample supply of water sufficient to turn several mills, and to give almost every house in town the benefit of it.

Swinburne's Travels, p. 283.

Many of the convents are remarkable for the beauty of their architecture; but in Seville the eye covets only pictures, of which there is a wonderful profusion. Among these are the works of the famous painter Murillo, with many others universally admired.

The convent of the Franciscans contains 15 cloisters, with apartments for 200 monks, though, when Mr Townsend visited them, they amounted only to 140. The annual expenditure of these, who are all fed on charity, is about 4000l. sterling. "In the principal cloister (says the same intelligent traveller), which is entirely inclosed by a multitude of little chapels, are represented, in 14 pictures, each called a *station*, all the sufferings of the Redeemer. These are so arranged as to mark given distances by walking round the cloister from the first to the second, and so in order to the rest. Over them is mentioned the number of steps taken by our Lord between the several incidents of his passion in his way to Calvary; and these precisely are the paces measured for the penitents in their progress from one station to another. Over one is the following inscription: 'This station consists of 1087 steps. Here the blessed Redeemer fell a second time under the weight of his cross, and here is to be gained the indulgence of seven years and forty quarantines. Mental prayer, the Paternoster, and the Ave Maria.' This may serve as an example for the rest."

Townsend's Travels, vol. ii. p. 326.

The principal manufacture of Seville is snuff. Mr Townsend, who paid particular attention to it, informs us, that the building in which it is carried on is elegant and simple in its form, and is about 600 feet by 480, and not less than 60 feet in height, with four regular fronts, inclosing 28 quadrangles. It cost 37,000,000 of reals, or about 370,000l. At present (1787), no more than 1700 workmen are employed, and 100 horses or mules; but formerly 3000 men were engaged, and near 400 horses. This falling off is attributed by Mr Swinburne to a practice which the directors followed, of adulterating the tobacco with the red earth of Almazarron. When Mr Townsend visited this manufacture, they had changed their system. From the year 1780, he informs us, the annual sale of tobacco from Brazil has been 1,500,000 pounds, purchased from the Portuguese at three reals a pound; and of snuff from the produce of their own colonies 1,600,000 pounds, beside *cigars* (A) to a very considerable amount. They have lying by them more than 5,000,000 pounds of snuff unsold; but as it will not suffer by age, they are not uneasy at this accumulation. Besides the peculiar kind of snuff with which Spain was accustomed to supply the market, they have lately introduced the manufacture of rappee. In this branch alone are employed 220 persons, old and young, with 16 mules.

"All the workmen (continues Mr Townsend) deposit their cloaks at the door; and when they go out are so strictly examined, that they have little chance of being able to conceal tobacco; yet they sometimes venture to hide it about their persons. An officer and a guard is always attending to take delinquents into custody; and that they may prevent resistance, no workman is permitted to enter with a knife. Were it not for this precaution, the consequence of a detection might be fatal. The whole business is conducted by a director, with a salary of 40,000 reals a-year, and 54 superior officers, assisted by as many subordinate to them. For grinding their snuff, they have 40 mills, each consisting of a stone roller, moved by a large horse or mule, with the traces fastened to a beam of eight feet in length, in the angle of 45 degrees, consequently losing precisely half his force."

Before Mr Townsend left Seville, according to his usual practice, which was truly laudable, he enquired into the prices of labour and provisions. As a piece of curious

(A) These are little rolls of tobacco which the Spaniards smoke without a pipe.

Sewer.

curious and useful information, and as an example to other travellers, we present them to our readers. They are as follows :

Day-labourers	$4\frac{1}{2}$ reals, about	L. 0	0	$10\frac{1}{4}$	
Carpenters from 7 to 11 ——					
Joiners, if good workmen,	24 —— or	0	4	9	
Weavers, if good workmen, 15 reals, about		0	3	0	
Bread, for 3 lb. of 16 oz. 16 quartos, or		0	0	$4\frac{1}{2}$	
—— sometimes 28 quartos, or		0	0	$7\frac{7}{8}$	
Beef, 30 quartos for 32 oz. per lb. about		0	0	$4\frac{1}{2}$	
Mutton, 38 do. do.		0	0	$5\frac{1}{3}\frac{1}{2}$	
Kid, 24 do.		0	0	$3\frac{3}{8}$	
Pork from 36 to 42 quartos, do.	or	0	0	$5\frac{1}{16}$	
	to	0	0	$5\frac{9}{11}$	

The price of wheat has at different periods been very remarkable. In 1652, it sold at the rate of 15s. $3\frac{1}{2}$d. the bushel ; and in 1657, it fell so low as 1s. $4\frac{1}{2}$d. per bushel, reckoning the fanega at $109\frac{1}{2}$ lb. and the bushel at 70.

SEVUM MINERALE, mineral tallow ; a substance somewhat resembling tallow, found on the sea-coasts of Finland in the year 1736. It burns with a blue flame, and smell of grease, leaving a black viscid matter which cannot easily be consumed. It is extremely light ; being only of the specific gravity of 0.770 ; whereas tallow is not less than 0.969. It is partly soluble in highly rectified spirit of wine ; but entirely so in expressed oils when boiling. It is met with in some of the rocky parts of Persia, but there it appears to be mixed with petrolæum. Dr Herman of Strasburg mentions a spring in the neighbourhood of that city which contains a substance of this sort diffused through it, separating, and capable of being collected on ebullition.—A fat mineral matter resembling butter or tallow has lately been extracted from peat in Lancashire. See PEAT.

SEWAURY, a Hindoo word used in Bengal, and signifying the train of attendants that accompany a nabob or great man.

SEWER, *in the Household*, an officer who arranged on the table the dishes of a king or nobleman.

SEWER is also a passage or gutter made to carry water into the sea or a river, whereby to preserve the land, &c. from inundations and other annoyances.

Court of Commissioners of SEWERS in England, a temporary tribunal, erected by virtue of a commission under the great seal ; which formerly used to be granted *pro re nata* at the pleasure of the crown, but now at the discretion and nomination of the lord chancellor, lord treasurer, and chief justices, pursuant to the statute 23 Hen. VIII. c. 5. Their jurisdiction is to overlook the repair of sea-banks and sea-walls, and the cleansing of rivers, public streams, ditches, and other conduits, whereby any waters are carried off ; and is confined to such county or particular district as the commission shall expressly name. The commissioners are a court of record, and may fine and imprison for contempts ; and in the execution of their duty may proceed by jury, or upon their own view, and may take order for the removal of any annoyances, or the safeguard and conservation of the sewers within their commission, either according to the laws and customs of Romney-marsh, or otherwise at their own discretion. They may also assess such rates or scots upon the owners of lands within their district as they shall judge necessary : and if any person refuses to pay them, the commissioners may levy the same by distress of his goods and chattels ; or they may, by statute 23 Hen. VIII. c. 5. sell his freehold lands (and by the 7 Ann. c. 10. his copyhold also), in order to pay such scots or assessments. But their conduct is under the controul of the court of King's-bench, which will prevent or punish any illegal or tyrannical proceedings. And yet in the reign of King James I. (8th Nov. 1616.), the privy-council took upon them to order, that no action or complaint should be prosecuted against the commissioners unless before that board ; and committed several to prison who had brought such actions at common law, till they should release the same : and one of the reasons for discharging Sir Edward Coke from his office of lord chief-justice, was for countenancing those legal proceedings. The pretence for these arbitrary measures was no other than the tyrant's plea of the *necessity* of unlimited powers in works of evident utility to the public, " the supreme reason above all reasons, which is the salvation of the king's lands and people." But now it is clearly held, that this (as well as all other inferior jurisdiction) is subject to the discretionary coercion of his majesty's court of King's-bench.

Ferguson's Roman History.

Common SEWERS, in Rome, were executed at a great expence. It was proposed that they should be of sufficient dimensions to admit a waggon loaded with hay. When these common sewers came to be obstructed, or out of repair, under the republic, the censors contracted to pay a thousand talents, or about 193,000l. for clearing and repairing them. They were again in disrepair at the accession of Augustus Cæsar, and the reinstating them is mentioned among the great works of Agrippa. He is said to have turned the course of seven rivers into these subterraneous passages, to have made them navigable, and to have actually passed in barges under the streets and buildings of Rome. These works are still supposed to remain ; but as they exceed the power and resources of the present city to keep them in repair, they are quite concealed, except at one or two places. They were in the midst of the Roman greatness, and still are, reckoned among the wonders of the world ; and yet they are said to have been works of the elder Tarquin, a prince whose territory did not extend, in any direction, above 16 miles ; and, on this supposition, they must have been made to accommodate a city that was calculated chiefly for the reception of cattle, herdsmen, and banditti. Rude nations sometimes execute works of great magnificence, as fortresses and temples, for the purposes of war and superstition ; but seldom palaces, and still more seldom works of mere convenience and cleanliness, in which for the most part they are long defective. It is not unreasonable, therefore, to question the authority of tradition in respect to this singular monument of antiquity, which so greatly exceeds what the best accommodated city of modern Europe could undertake for its own conveniency. And as those works are still entire, and may continue so for thousands of years, it may be suspected that they were even prior to the settlement of Romulus, and may have been the remains of a more ancient city, on the ruins of which the followers of Romulus settled, as the Arabs now hut or encamp.

Sewers, Sex.

ers the ruins of Palmyra and Balbeck. Livy owns, that the common ſewers were not accommodated to the plan of Rome, as it was laid out in his time; they were carried in directions acroſs the ſtreets, and paſſed under buildings of the greateſt antiquity. This derangement indeed he imputes to the haſty rebuilding of the city after its deſtruction by the Gauls; but haſte, it is probable, would have determined the people to build on their old foundations, or at leaſt not to change them ſo much as to croſs the direction of former ſtreets.

SEX, the property by which any animal is male or female.

Lavater has drawn the following characteriſtic diſtinctions between the male and female of the human ſpecies.

"The primary matter of which women are conſtituted appears to be more flexible, irritable, and elaſtic, than that of man. They are formed to maternal mildneſs and affection; all their organs are tender, yielding, eaſily wounded, ſenſible, and receptible. Among a thouſand females there is ſcarcely one without the generic feminine ſigns; the flexible, the circular, and the irritable.

"They are the counterpart of man, taken out of man, to be ſubject to man; to comfort him like angels, and to lighten his cares. 'She ſhall be ſaved in childbearing, if they continue in faith, and charity, and holineſs, with ſobriety" (1 Tim. ii. 15.). This tenderneſs, this ſenſibility, this light texture of their fibres and organs, this volatility of feeling, render them ſo eaſy to conduct and to tempt; ſo ready of ſubmiſſion to the enterpriſe and power of the man; but more powerful through the aid of their charms than man with all his ſtrength. The man was not firſt tempted, but the woman, afterward the man by the woman. And, not only eaſy to be tempted, ſhe is capable of being formed to the pureſt, nobleſt, moſt ſeraphic virtue; to every thing which can deſerve praiſe or affection. Highly ſenſible of purity, beauty, and ſymmetry, ſhe does not always take time to reflect on internal life, internal death, internal corruption. 'The woman ſaw that the tree was good for food, and that it was pleaſant to the eyes, and a tree to be deſired to make one wiſe, and ſhe took of the fruit thereof.' (Gen. iii. 6.).

"The female thinks not profoundly; profound thought is the power of the man. Women feel more. Senſibility is the power of woman. They often rule more effectually, more ſovereignly, than man. They rule with tender looks, tears, and ſighs: but not with paſſion and threats: for if, or when, they ſo rule, they are no longer women, but abortions. They are capable of the ſweeteſt ſenſibility, the moſt profound emotion, the utmoſt humility, and the exceſs of enthuſiaſm. In their countenance are the ſigns of ſanctity and inviolability, which every feeling man honours, and the effects of which are often miraculous. Therefore, by the irritability of their nerves, their incapacity for deep inquiry and firm deciſion, they may eaſily from their extreme ſenſibility become the moſt irreclaimable, the moſt rapturous enthuſiaſts. Their love, ſtrong and rooted as it is, is very changeable; their hatred almoſt incurable, and only to be effaced by continued and artful flattery. Men are moſt profound; women are more ſublime.

"Men more embrace the whole; women remark individually, and take more delight in ſelecting the minutiæ which form the whole. Man hears the burſting thunder, views the deſtructive bolt with ſerene aſpect, and ſtands erect amidſt the fearful majeſty of the ſtreaming clouds. Woman trembles at the lightning, and the voice of diſtant thunder; and ſhrinks into herſelf or ſinks into the arms of man. Man receives a ray of light ſingle, woman delights to view it through a priſm in all its dazzling colours. She contemplates the rainbow as the promiſe of peace; he extends his inquiring eye over the whole horizon. Woman laughs, man ſmiles; woman weeps, man remains ſilent. Woman is in anguiſh when man weeps, and in deſpair when man is in anguiſh; yet has ſhe often more faith than man. Man without religion, is a diſeaſed creature, who would perſuade himſelf he is well, and needs not a phyſician; but woman without religion, is raging and monſtrous. A woman with a beard is not ſo diſguſting as a woman who acts the freethinker; her ſex is formed to piety and religion; to them Chriſt firſt appeared; but he was obliged to prevent them from too ardently, and too haſtily, embracing him: 'Touch me not.' They are prompt to receive and ſeize novelty, and become its enthuſiaſts. The whole world is forgotten in the emotion cauſed by the preſence and proximity of him they love. They ſink into the moſt incurable melancholy, as they alſo riſe to the moſt enraptured heights.

"Male ſenſation is more imagination, female more heart. When communicative, they are more communicative than man; when ſecret, more ſecret. In general they are more patient, long-ſuffering, credulous, benevolent, and modeſt. Woman is not a foundation on which to build. She is the gold, ſilver, precious ſtones, wood, hay, ſtubble (1 Cor. iii. 12.); the materials for building on the male foundation. She is the leaven, or more expreſſively the oil to the vinegar of man: the ſecond part of the book of man.

"Man ſingly is but half man; at leaſt but half human; a king without a kingdom. Woman, who feels properly what ſhe is, whether ſtill or in motion, reſts upon the man; nor is man what he may and ought to be, but in conjunction with woman; therefore, 'it is not good that man ſhould be alone, but that he ſhould leave father and mother, and cleave to his wife, and they two ſhall be one fleſh."

They differ alſo in their exterior form and appearance.

"Man is the moſt firm; woman the moſt flexible. Man is the ſtraighteſt; woman the moſt bending. Man ſtands ſtedfaſt: woman gently retreats. Man ſurveys and obſerves; woman glances and feels. Man is ſerious; woman is gay. Man is the talleſt and broadeſt; woman the ſmalleſt and weakeſt. Man is rough and hard; woman ſmooth and ſoft. Man is brown; woman is fair. Man is wrinkly; woman is not. The hair of man is more ſtrong and ſhort; of woman more long and pliant. The eyebrows of man are compreſſed; of woman leſs frowning. Man has moſt convex lines; woman moſt concave. Man has moſt ſtraight lines, woman moſt curved. The countenance of man taken in profile is more ſeldom perpendicular than that of the woman. Man is moſt angular; woman moſt round."

In determining the comparative merit of the two ſexes, it is no derogation from female excellency that it differs in kind from that which diſtinguiſhes the male part of our ſpecies: and if, in general, it ſhould be found (wh… upon an impartial inquiry will moſt certainly be found) that women fill up their appointed circle of action with greater regularity than men, the claim of preference cannot juſtly be decided in our favour. In the prudential and economical parts of life, it is undeniable that they riſe far above us: and if true fortitude of mind is beſt diſcovered by a cheerful reſignation to the meaſures of Providence, we ſhall not find reaſon, perhaps, to claim that moſt ſingular of the human virtues as our peculiar privilege. There are numbers of the other ſex who, from the natural delicacy of their conſtitution, paſs through one continued ſcene of ſuffering from their cradles to their graves, with a firmneſs of reſolution that would deſerve ſo many ſtatues to be erected to their memories, if heroiſm were not eſteemed more by the ſplendor than the merit of actions.

But whatever real difference there may be between the moral or intellectual powers of the male and female mind, Nature does not ſeem to have marked the diſtinction ſo ſtrongly as our vanity is willing to imagine; and after all, perhaps, education will be found to conſtitute the principal ſuperiority. It muſt be acknowledged, at leaſt, that in this article we have every advantage over the ſofter ſex that art and induſtry can poſſibly ſecure to us. The moſt animating examples of Greece and Rome are ſet before us, as early as we are capable of any obſervation; and the nobleſt compoſitions of the ancients are given into our hands almoſt as ſoon as we have ſtrength to hold them; while the employments of the other ſex, at the ſame period of life, are generally the reverſe of every thing that can open and enlarge their minds, or fill them with juſt and rational notions. The truth of it is, female education is ſo much worſe than none, as it is better to leave the mind to its natural and uninſtructed ſuggeſtions, than to lead it into falſe purſuits, and contract its views, by turning them upon the loweſt and moſt trifling objects. We ſeem, indeed, by the manner in which we ſuffer the youth of that ſex to be trained, to conſider women agreeably to the opinion of certain Mahometan doctors, and treat them as if we believed they had no ſouls: why elſe are they

> Bred only, and completed to the taſte
> Of luſtful appetence, to ſing, to dance,
> To dreſs, and troul the tongue, and roll the eye.
>
> MILTON.

This ſtrange neglect of cultivating the female mind can hardly be allowed as good policy, when it is conſidered how much the intereſt of ſociety is concerned in the rectitude of their underſtandings. That ſeaſon of every man's life which is moſt ſuſceptible of the ſtrongeſt impreſſions, is neceſſarily under female direction; as there are few inſtances, perhaps, in which that ſex is not one of the ſecret ſprings which regulates the moſt important movements of private or public tranſactions. What Cato obſerves of his countrymen is in one reſpect true of every nation under the ſun: "The Romans (ſaid he) govern the world, but it is the women that govern the Romans."

If it be true then (as true beyond all peradventure it is) that female influence is thus extenſive, nothing certainly can be of more importance than to give it a proper tendency, by the aſſiſtance of a well-directed education. Far are we from recommending any attempts to render women learned; yet ſurely it is neceſſary they ſhould be raiſed above ignorance. Such a general tincture of the moſt uſeful ſciences as may ſerve to free the mind from vulgar prejudices, and give it a reliſh for the rational exerciſe of its powers, might very juſtly enter into a plan of female erudition. That ſex might be taught to turn the courſe of their reflections into a proper and advantageous channel, without any danger of rendering them too elevated for the feminine duties of life. In a word, they ought to be conſidered as deſigned by Providence for uſe as well as ſhow, and trained up, not only as women, but as rational creatures.

Sex, ‖ Sextius.

SEX of Bees. See BEE.

SEX of Plants. See BOTANY *Index*.

SEXAGENARY, ſomething relating to the number ſixty: thus ſexagenary or ſexageſimal arithmetic is a method of computation proceeding by ſixties; ſuch is that uſed in the diviſion of a degree into ſixty minutes, of the minute into ſixty ſeconds, of the ſecond into ſixty thirds, &c. Alſo ſexagenary tables are tables of proportional parts, ſhowing the product of two ſexagenaries that are to be multiplied, or the quotient of the two that are to be divided.

SEXAGESIMA, the ſecond Sunday before Lent, or the next to Shrove-Sunday; ſo called as being about the 60th day before Eaſter.

SEXAGESIMALS, or *SEXAGESIMAL Fractions*, fractions whoſe denominators proceed in a ſexagecuple ratio; that is, a prime, or the firſt minute $=\frac{1}{60}$; a ſecond $=\frac{1}{3600}$; a third $=\frac{1}{216000}$. Anciently, there were no other than ſexageſimals uſed in aſtronomy; and they are ſtill retained in many caſes, though decimal arithmetic begins to grow in uſe now in aſtronomical calculations. In theſe fractions, which ſome call *aſtronomical fractions*, the denominator being always 60, or a multiple thereof, is uſually omitted, and the numerator only written down: thus $4^{\circ}, 59', 32'', 50''', 16''''$, is to be read, 4 degrees, 59 minutes, 32 ſeconds, 50 thirds, 16 fourths, &c.

SEXTANS, SEXTANT, a ſixth part of certain things. The Romans having divided their *as* into 12 ounces or unciæ, the ſixth part of that, or two ounces, was the ſextans.—*Sextans* was alſo a meaſure which contained two ounces of liquor, or two cyathi.

SEXTANS, in *Aſtronomy*, a conſtellation of the ſouthern hemiſphere, made by Hevelius out of unformed ſtars. In Hevelius's catalogue it contains 11, but in the Britannic catalogue 41 ſtars.

SEXTANT, in *Mathematics*, denotes the ſixth part of a circle, or an arch comprehending 60 degrees.

The word *ſextant* is more particularly uſed for an aſtronomical inſtrument made like a quadrant, excepting that its limb only comprehends 60 degrees. The uſe and application of the ſextant is the ſame with that of the quadrant. See QUADRANT; and NAVIGATION, p. 699, &c.

SEXTILE, SEXTILIS, the poſition or aſpect of two planets when at 60 degrees diſtance, or at the diſtance of two ſigns from one another. It is marked thus (*). See ASPECT.

SEXTIUS, QUINTUS, a Pythagorean philoſopher, flouriſhed in the time of Auguſtus. He ſeemed formed to riſe in the republic; but he ſhrunk from civil honours, and declined accepting the rank of ſenator when it was offered him by Julius Cæſar, that he might have time

time to apply to philosophy. It appears that he wished to establish a school at Rome, and that his tenets, though chiefly drawn from the doctrines of Pythagoras, in some particulars resembled those of the Stoics.

He soon found himself involved in many difficulties. His laws were tinctured with great severity; and in an early period of this establishment, he found his mind so harassed, and the harshness of the doctrines which he wished to establish so repulsive to his feelings, that he had nearly worked himself up to such an height of desperation as to resolve on putting a period to his existence.

Of the school of Sextius were Fabianus, Sotion, Flavianus, Crassitius, and Celsus. Of his works only a few fragments remain; and whether any of them formed a part of the work which Seneca admired so much, cannot now be determined. Some of his maxims are valuable. He recommended an examination of the actions of the day to his scholars when they retired to rest; he taught, that the road to heaven *(ad astra)* was by frugality, temperance, and fortitude. He used to recommend holding a looking glass before persons disordered with passion. He enjoined his scholars to abstain from animal food.

SEXTON, a church-officer, thus called by corruption of the Latin *sacrista*, or Saxon *segerstone*, which denotes the same. His office is to take care of the vessels, vestments, &c. belonging to the church; and to attend the minister, church-warden, &c. at church. He is usually chosen by the parson only. Sextons, as well as parish-clerks, are regarded by the common law as persons who have freehold in their offices; and, therefore, though they may be punished, yet they cannot be deprived, by ecclesiastical censures.

The office of sexton in the pope's chapel is appropriated to the order of the hermits of St Augustine. He is generally a bishop, though sometimes the pope only gives a bishopric, *in partibus*, to him on whom he confers the post. He takes the title of *Prefect of the Pope's Sacristy*, and has the keeping the vessels of gold and silver, the relics, &c. When the pope says mass, the sexton always takes the bread and wine first. If it be in private he says mass, his holiness, of two wafers, gives him one to eat; and, if in public, the cardinal, who assists the pope in quality of deacon, of three wafers, gives him one to eat. When the pope is desperately sick, he administers to him the sacrament of extreme unction, &c. and enters the conclave in quality of first conclavist.

The office of a sexton in Sweden is sometimes singular. During M. Outhier's stay at Stockholm in 1736 he visited the church of St Clara, and during divine service he observed a sexton going about with a long rod, waking those persons who had fallen asleep.

SEXTUPLE, in *Music*, denotes a mixed sort of triple, which is beaten in double time.

SEXTUS EMPIRICUS, a famous Pyrrhonian philosopher, lived in the second century, under the reign of Antoninus the Debonair. He was a physician of the sect of the Empirics, and is said to have been one of the preceptors of Antoninus the philosopher. There are still extant his Pyrrhonian Institutions, and a large work against the mathematicians, &c. The best edition of Sextus Empiricus is that of Fabricius in Greek and Latin, printed at Leipsic in 1718, folio.

SEXUALISTÆ, among botanical writers, those who have established the classes of plants upon the differences of the sexes and parts of fructification in plants, according to the modern method; as Linnæus, &c.

SEZAWUL, a Hindoo word, used in Bengal to express an officer employed at a monthly salary to collect the revenues.

SFORZA, JAMES, was the founder of the illustrious house of Sforza, which acted so conspicuous a part in Italy during the 15th and 16th centuries, which gave six dukes to Milan, and contracted alliances with almost every sovereign in Europe. James Sforza was born on the 28th of May 1369, at Catignola, a small town in Italy, lying between Imola and Faenza. His father was a day labourer, or, according to Commines, a shoemaker. A company of soldiers happening one day to pass through Catignola, he was seized with the desire of accompanying them to the wars. "I will go (said he to himself), and dart my hatchet against that tree, and if it stick fast in the wood, I will immediately become a soldier." The hatchet accordingly stuck fast, and our adventurer enlisted; and because, says the Abbé de Choisi, he had thrown the axe with all his force, he assumed the name of Sforza; for his true name was Giacomuzzo, or James Attendulo. He rose rapidly in the army, and soon became commander of 7000 men. He defended the cause of Jane II. queen of Naples for many years, and was made constable of her kingdom. He was created Count of Catignola by Pope John XXII. by way of paying a debt of 14000 ducats which the church of Rome owed him. His exploits became every day more illustrious: He obliged Alphonso king of Arragon to raise the siege of Naples; and reduced several places that had revolted in Abruzzo and Le Labour; but while in pursuit of his enemies he was unfortunately drowned in the river Aterno on the 3d January 1424, at the age of 54 years. His heroic qualities, and the continual wars in which he was engaged, did not prevent him from forming an attachment to the fair sex. In his youth he fell in love with a woman called *Lucia Trezana*, whom he married after she had born him several children. He married afterwards Antoinette Salembini, who brought him several excellent estates; she bore him Bosio Sforza, compte of Santa-Flor, a warrior and governor of Orvietta for Pope Martin V. His third wife was Catharine Alopo, sister of Rodolpho, grand chamberlain to the sovereign of Naples. His last wife, for he was four times married, was Mary Marzana, daughter to the duke of Sessa. She bore him Charles Sforza, who was general of the order of Augustines, and archbishop of Milan.

SFORZA, *Francis*, the son of James Sforza by Lucia Trezana, was born in 1401, and trained up by his father to the profession of arms. At the age of 23 he defeated the troops of Braccio, who disputed with him the passage of the Aterno. In this action his father was drowned, and Francis, though illegitimate, succeeded him. He fought successfully against the Spaniards, and contributed a great deal both towards raising the siege of Naples, and to the victory which was gained over the troops of Braccio near Aquila in 1425, where that general was killed. After the death of Queen Jane, in 1435, he espoused the interests of the duke of Anjou, to whom she had left her crown, and by his courage and abilities ably supported that unfortunate

Florentine prince. He made himself master of several places in Ancona, from which he was driven by Pope Eugenius IV. who detested and excommunicated him; but he soon re-established his affairs by a victory. His reputation was now so great, that the pope, the Venetians, and the Florentines, chose him for their general against the duke of Milan. Sforza had already conducted Venetian armies against that prince, though he had espoused his daughter. The duke dying in 1447, the inhabitants of Milan invited Sforza, his son-in-law, to lead them against that duke. But, after some exertions in their favour, he turned his arms against themselves, laid siege to Milan, and obliged them to receive him as duke, notwithstanding the rights of Charles duke of Orleans, the son of Valentine of Milan. In 1464, Louis XI. who hated Orleans, gave up to Sforza the rights which the crown of France had over Genoa, and even put into his hands Savona, a town belonging to that republic. The duke of Milan soon after made himself master of Genoa. He died in 1466, with the reputation of a man who was willing to sell his blood to the best purchaser, and who was not too scrupulous an observer of his word. His second wife was Blanche Marie, natural daughter of Philip Marie duke of Milan. She bore him Galeas Marie, and Ludovic Marie, dukes of Milan, Philip Marie count of Pavia, Sforza Marie duke of Bari, Ascagne Marie bishop of Pavia and Cremona, and a cardinal. He was taken prisoner by the troops of Louis XII. and confined for some time in the tower of Bourges. He was a cunning man, and deceived Cardinal d'Amboise when that prelate aspired at the papacy. His daughters were Hyppolita, married to Alphonso of Arragon, afterwards king of Naples; and Elizabeth, married to William marquis of Montferrat. He had besides several natural children.

SHACK, in ancient customs, a liberty of winter-pasturage. In the counties of Norfolk and Suffolk, the lord of the manor has shack, i. e. a liberty of feeding his sheep at pleasure in his tenants lands during the six winter months. In Norfolk, shack also extends to the common for hogs, in all men's grounds, from the end of harvest till seed-time. Whence to go *a-shack*, is to feed at large.

SHACKLES, aboard a ship, are those oblong iron rings, bigger at one end than at the other, with which the ports are shut fast, by thrusting the wooden bar of the port through them. There is also a sort of shackles to lift the hatches up with, of a like figure, but smaller. They are fastened at the corners of the hatches.

SHAD, a species of CLUPEA. See ICHTHYOLOGY *Index*.

SHADDOCK, a species of CITRUS, the fruit of which is of a very large size, and of a very grateful taste. In the West Indies it is eaten after dinner to give a zest to the wine.

SHADOW, in *Optics*, a privation or diminution of light, by the interposition of an opaque body; or it is a plane where the light is either altogether obstructed, or greatly weakened, by the interposition of some opaque body between it and the luminary.

SHADOW, in *Painting*, an imitation of a real shadow, effected by gradually heightening and darkening the colours of such figures as by their dispositions cannot receive any direct rays from the luminary that is supposed to enlighten the piece.

SHADOW, in *Perspective*, the appearance of an opaque body, and a luminous one, whose rays diverge (e. g. a candle, lamp, &c.), being given; to find the just appearance of the shadow, according to the laws of perspective. The method is this: From the luminous body, which is here considered as a point, let fall a perpendicular to the perspective plane or table; i. e. find the appearance of a point upon which a perpendicular, drawn from the middle of the luminary, falls on the perspective plane; and from the several angles, or raised points of the body, let fall perpendiculars to the plane. These points, whereon the perpendiculars fall, connect by right lines, with the point upon which the perpendicular let fall from the luminary falls; and continue the lines to the side opposite to the luminary. Lastly, through the raised points draw lines through the centre of the luminary, intersecting the former; the points of intersection are the terms or bounds of the shadow.

SHADOWS, COLOURED, a curious phenomenon in optics, which was observed by Professor Scherffer of Vienna, and afterwards by Count Rumford, who made the discovery while prosecuting his experiments on light.

"Desirous," says the count, "of comparing the intensity of the light of a clear blue sky by day with that of a common wax candle, I darkened my room, and letting the day-light from the north, coming through a hole near the top of the window-shutter, fall at an angle of about 70° upon a sheet of very fine white paper, I placed a burning wax candle in such a position that its rays fell upon the same paper, and, as near as I could guess, in the line of reflection of the rays of day-light from without; when, interposing a cylinder of wood, about half an inch in diameter, before the centre of the paper, and at the distance of about 2 inches from its surface, I was much surprised to find that the two shadows projected by the cylinder upon the paper, instead of being merely shades without colour, as I expected; the one of them, that which, corresponding with the beam of day light, was illuminated by the candle, was yellow; while the other, corresponding to the light of the candle, and consequently illuminated by the light of the heavens, was of the most beautiful blue that it is possible to imagine. This appearance, which was not only unexpected, but was really in itself in the highest degree striking and beautiful, I found upon repeated trials, and after varying the experiment in every way I could think of, to be so perfectly permanent, that it is absolutely impossible to produce two shadows at the same time, from the same body, the one answering to a beam of day-light, and the other to the light of a candle or lamp, without those shadows being coloured, the one yellow, and the other blue.

"If the candle be brought nearer to the paper, the blue shadow will become of a deeper hue, and the yellow shadow will gradually grow fainter; but if it be removed farther off, the yellow shade will become of a deeper colour, and the blue shade will become fainter; and the candle remaining stationary in the same place, the same varieties in the strength of the tints of the coloured shades may be produced merely by opening the window shutter a little more or less, and rendering the illumination of the paper, by the light from without, stronger or weaker. By either of these means, the coloured shadows may be made to pass through all the gradations of shade from the deepest to the lightest, and

vice

Shadows || Shafras.

vice versa; and it is not a little amusing to see shadows thus glowing with all the brilliancy of the purest and most intense prismatic colours, then passing suddenly through all the varieties of shade, preserving in all the most perfect purity of tint, growing stronger and fainter, and vanishing and returning, at command *."

* Phil. Transf. 1794.

The count is clearly of opinion, that the causes of the colours of these shadows arise from the different qualities of the light by which they are illuminated; but he does not think it so evident how they are produced. Perhaps it may be said, however, that all the phenomena of coloured shadows which the count enumerates may be accounted for by the theory of Professor Scheffer.

SHADWELL, Thomas, descended of an ancient family in Staffordshire, was born in 1640, and educated at Caius college, Cambridge. He then was placed in the Middle Temple to study the laws; where having spent some time, he travelled abroad. Upon his return home, he became acquainted with the most celebrated persons of wit in that age. He applied himself chiefly to dramatic writing, in which he had great success; and upon the revolution was made poet laureat and historiographer to King William and Queen Mary, in the room of Mr Dryden. These employments he enjoyed till his death, which happened in 1692. Beside his dramatic writings, he composed several other pieces of poetry; the chief of which are his congratulatory poem on the prince of Orange's coming to England; another on Queen Mary; his translation of Juvenal's 10th satire, &c. Mr Dryden treats him with great contempt, in his satire called *Mac-Flecno*. The best judges of that age, however, gave their testimony in favour of his comedies; which have in them fine strokes of humour; the characters are often original, strongly marked, and well sustained. An edition of his works, with some account of his life and writings prefixed, was published in 1720, in 4 vols 8vo.

SHAFRAS, or Suffras, Gregory Savarof, an Armenian merchant, remarkable only as the person who sold the large and celebrated diamond which is now set in the imperial sceptre of Russia. Shah Nadir, an Indian prince, had two principal diamonds in his throne, one of them denominated the *Sun of the Sea*, and the other the *Moon of the Mountain*. When that prince was assassinated, many precious ornaments belonging to the crown were pillaged, and privately disposed of by the soldiers who shared the plunder. See Diamond, under Mineralogy, where the account given of this diamond is somewhat different.

Shafras, who was called *Millionshik* at Astracan, then had his residence at Bassora, with two of his brothers. A chief of the Avganians one day applied to him, and proposed to sell the diamond already mentioned for a very moderate sum, probably the Moon of the Mountain, together with a very large emerald, a ruby of considerable size, and other precious stones of less value. Shafras was astonished at the offer; and giving out that he had not a sufficient sum to purchase them, he requested time to consult with his brothers on the subject. The vender did not again make his appearance, probably from [illegible]. Shafras, with the approbation of his brothers, went directly in search of the [illegible]ger with the jewels, but by that time he had left Bassora. Shafras, however, accidentally met him at [illegible], and [illegible] 895[illegible]

Shafras || Shaftsbury

for all his jewels. Shafras and his brothers being well aware that the most profound secrecy was absolutely necessary, resolved to remain at Bassora.

At the expiration of 12 years, Shafras set off with the largest of the jewels, directing his route through Sham and Constantinople, and afterwards through Hungary and Silesia to the city of Amsterdam by land, where he publicly offered them for sale.

It is reported that the British government was among the bidders. The Russian court sent for the large diamond, with an offer to reimburse all reasonable expences, if the price could not be agreed on. When the diamond arrived, Count Panin, the Russian minister, made the following offer to Shafras. Besides the patent of hereditary nobility, which the vender demanded, he was to receive an annual pension of 6000 rubles during life, 500,000 rubles in cash (112,500l. Sterling), one-fifth of which was to be payable on demand, and the remainder by instalments in the course of ten years. He also claimed the order of nobility for his brothers, persisting so obstinately in his demands, that the diamond was returned.

Shafras was now very much perplexed. He had involved himself in expences, was forced to pay interest for considerable sums of borrowed money, and the law no prospect of selling the jewel to advantage. The negociation was recommenced with Russia by Count Gregory Grigorievitch Orlof, afterwards created a prince of the empire; and the diamond was purchased for 450,000 rubles (105,250l.) ready money, together with a grant of Russian nobility. We are informed that 120,000 rubles (27,000l.), fell to the share of the negociators, for commission, interest, and similar expences. Shafras settled at Astracan; and his riches, which by inheritance devolved to his daughters, have been in a great measure dissipated by the extravagance of his sons-in law.

SHAFT *of a* Column, in *Building*, is the body thereof between the base and capital; so called from its straightness. See Architecture.

Shaft, in mining, is the pit or hollow entrance into the mine. In the tin mines, after this is sunk about a fathom, they leave a little, long, square place, which is called a *shamble*.

Shafts are sunk some ten, some twenty fathoms deep into the earth, more or less. Of these shafts, there is the landing or working shaft, where they bring up the work or ore to the surface; but if it be worked by a horse engine or whim, it is called a *whim shaft*: and when the water is drawn out of the mine, it is indifferently named an *engine-shaft*, or the *rod shaft*. See Mine.

Shaft. See Trochilus, Ornithology *Index*.

SHAFTESBURY, a town of Dorsetshire in England, in W. Long. 2. 20. N. Lat. 51. 0. It stands on a high hill, and is built in the form of a bow. It enjoys a fine wholesome air, and has a fine prospect. It is a good thoroughfare, is governed by a mayor, and sends two members to parliament. This town is supposed to have been built in the 8th century, and to have been enlarged by King Alfred; and had 12 churches, besides a Benedictine monastery, in the time of the Saxons, but has now only three. St Edward the martyr was buried here. It had three mints before the [illegible], and, in the reign of Henry VIII. was the [illegible]

large

fragan bishop. It was incorporated by Queen Elizabeth and Charles II. and is governed by a mayor, recorder, twelve aldermen, bailiffs, and a common-council. It contains about 320 houses, many of which are of free-stone. Water is so scarce, that it used to be supplied from Motcomb; but it was obtained more commodiously in 1718, by means of engines, which raised the water above 300 feet perpendicular, and conveyed it to a large cistern in the middle of the town, from the distance of two miles. Yet even this is laid aside, and they have dug several pits, in which they preserve the rain-water; and the poor get their living to this day by fetching it in pails or on horses. It gives the title of earl to the noble family of Cooper.

SHAFTESBURY, *Earl of*. See COOPER.

SHAG. See PELICANUS, ORNITHOLOGY *Index*.

SHAGREEN, or CHAGREEN, in *Commerce*, a kind of grained leather prepared of the skin of a species of SQUALUS, and much used in covering cases, books, &c.

The best is that brought from Constantinople, of a brownish colour; the white is the worst. It is extremely hard; yet, when steeped in water, it becomes very soft and pliable; whence it is of great use among case-makers. It takes any colour that is given it, red, green, yellow, or black. It is frequently counterfeited by morocco, formed like shagreen; but this last is distinguished by its peeling off, which the first does not.

The following is the method of preparing shagreen, as it is described by Professor Pallas.

" All kinds of horses or asses skins, which have been dressed in such a manner as to appear grained, are, by the Tartars, called *sauwer*, by the Persians *sogre*, and by the Turks *sogri*, from which the Europeans have made *shagreen* or *chagrin*. The Tartars who reside at Astracan, with a few of the Armenians of that city, are the only people in the Russian empire acquainted with the art of making shagreen. Those who follow this occupation not only gain considerable profit by the sale of their production to the Tartars of Cuban, Astracan, and Casan, who ornament with it their Turkey leather boots, slippers, and other articles made of leather, but they derive considerable advantage from the great sale of horses hides, which have undergone no other process than that of being scraped clean, and of which several thousands are annually exported, at the rate of from 75 to 85 roubles per hundred, to Persia, where there is a scarcity of such hides, and from which the greater part of the shagreen manufactured in that country is prepared. The hind part only of the hide, however, which is cut out in the form of a crescent about a Russian ell and a half in length across the loins, and a short ell in breadth along the back, can properly be employed for shagreen. The remaining part, as is proved by experience, is improper for that purpose, and is therefore rejected.

" The preparation of the skins, after being cut into the above form, is as follows:—They are deposited in a tub filled with pure water, and suffered to remain there for several days, till they are thoroughly soaked, and the hair has dropped off. They are then taken from the tub, one by one, extended on boards placed in an oblique direction against a wall, the corners of them, which reach beyond the edges of the board, being made fast, and the hair with the epidermis is then scraped off with a blunt iron scraper called *urak*. The skins thus cleaned are again put in pure water to soak. When all the skins have undergone this part of the process, they are taken from the water a second time, spread out one after the other as before, and the flesh side is scraped with the same kind of instrument. They are carefully cleaned also on the hair side, so that nothing remains but the pure fibrous tissue, which serves for making parchment, consisting of coats of white medullary fibres, and which has a resemblance to a swine's bladder softened in water.

" After this preparation, the workmen take a certain kind of frames called *pälzi*, made of a straight and a semicircular piece of wood, having nearly the same form as the skins. On these the skins are extended in as smooth and even a manner as possible by means of cords; and during the operation of extending them, they are several times besprinkled with water, that no part of them may be dry, and occasion an unequal tension. After they have been all extended on the frames, they are again moistened, and carried into the house, where the frames are deposited close to each other on the floor with the flesh side of the skin next the ground. The upper side is then thickly bestrewed with the black exceedingly smooth and hard seeds of a kind of goose foot (*chenopodium album*), which the Tartars call *alabuta*, and which grows in abundance, to about the height of a man, near the gardens and farms on the south side of the Volga; and that they may make a strong impression on the skins, a piece of felt is spread over them, and the seeds are trod down with the feet, by which means they are deeply imprinted into the soft skins. The frames, without shaking the seeds, are then carried out into the open air, and placed in a reclining position against a wall to dry, the side covered with the seeds being next the wall, in order that it may be sheltered from the sun. In this state the skins must be left several days to dry in the sun, until no appearance of moisture is observed in them, when they are fit to be taken from the frames. When the impressed seeds are beat off from the hair side, it appears full of indentations or inequalities, and has acquired that impression which is to produce the grain of the shagreen, after the skins have been subjected to the last smoothing or scraping, and have been dipped in a ley, which will be mentioned hereafter, before they receive the dye.

" The operation of smoothing is performed on an inclined bench or board, which is furnished with an iron hook, and is covered with thick felt of sheep's wool, on which the dry skin may gently rest. The skin is suspended in the middle of the bench or board to its iron hook, by means of one of the holes made in the edge of the skin for extending it in its frame as before mentioned; and a cord, having at its extremity a stone or a weight, is attached to each end of the skin, to keep it in its position while under the hands of the workman. It is then subjected to the operation of smoothing and scraping by means of two different instruments. The first used for this purpose, called by the Tartars *tokar*, is a piece of sharp iron bent like a hook, with which the surface of the shagreen is pretty closely scraped to remove all the projecting inequalities. This

Shagreen. This operation, on account of the corneous hardneſs of the dry ſkin, is attended with ſome difficulty; and great caution is at the ſame time required that too much of the impreſſion of the *alabuta* ſeed be not deſtroyed, which might be the caſe if the iron were kept too ſharp. As the iron, however, is pretty blunt, which occaſions inequalities on the ſhagreen, this inconvenience muſt afterwards be remedied by means of a ſharp ſcraping iron or *urak*, by which the ſurface acquires a perfect uniformity, and only faint impreſſions of the *alabuta* ſeed then remain, and ſuch as the workman wiſhes. After all theſe operations, the ſhagreen is again put into water, partly to make it pliable, and partly to raiſe the grain. As the ſeeds occaſion indentations on the ſurface of the ſkin, the intermediate ſpaces, by the operations of ſmoothing and ſcraping, loſe ſome part of their projecting ſubſtance; but the points which have been depreſſed, and which have loſt none of their ſubſtance, now ſwell up above the ſcraped parts, and thus form the grain of the ſhagreen. To produce this effect, the ſkins are left to ſoak in water for 24 hours; after which they are immerſed ſeveral times in a ſtrong warm ley, obtained, by boiling, from a ſtrong alkaline earth named *ſchora*, which is found in great abundance in the neighbourhood of Aſtracan. When the ſkins have been taken from this ley, they are piled up, while warm, on each other, and ſuffered to remain in that ſtate ſeveral hours; by which means they ſwell, and become ſoft. They are then left 24 hours in a moderately ſtrong pickle of common ſalt, which renders them exceedingly white and beautiful, and fit for receiving any colour. The colour moſt uſual for theſe ſkins is a ſea-green; but old experienced workmen can dye them blue, red, or black, and even make white ſhagreen.

" For the green colour nothing is neceſſary but filings of copper and ſal ammoniac. Sal ammoniac is diſſolved in water till the water is completely ſaturated; and the ſhagreen ſkins, ſtill moiſt, after being taken from the pickle, are waſhed over with the ſolution on the ungrained fleſh ſide, and when well moiſtened a thick layer of copper filings is ſtrewed over them: the ſkins are then folded double, ſo that the ſide covered with the filings is innermoſt. Each ſkin is then rolled up in a piece of felt; the rolls are all ranged together in proper order, and they are preſſed down in an uniform manner by ſome heavy bodies placed over them, under which they remain 24 hours. During that period, the ſolution of ſal ammoniac diſſolves a quantity of the cupreous particles ſufficient to penetrate the ſkin, and to give it a ſea-green colour. If the firſt application be not ſufficient, the proceſs is repeated in the ſame manner; after which the ſkins are ſpread out and dried.

" For the blue dye, indigo is uſed. About two pounds of it, reduced to a fine powder, are put into a kettle; cold water is poured over it, and the mixture is ſtirred round till the colour begins to be diſſolved. Five pounds of pounded *alakar*, which is a kind of barilla or crude ſoda, prepared by the Armenians and Calmucs, is then diſſolved in it, with two pounds of lime and a pound of pure honey, and the whole is kept ſeveral days in the ſun, and during that time frequently ſtirred round. The ſkins intended to be dyed blue muſt be moiſtened only in the natrous ley *ſchora*, but not in the ſalt brine. When ſtill moiſt, they are folded up and ſewed together at the edge, the fleſh ſide being innermoſt, and the ſhagreened hair ſide outwards; after which they are dipped three times in the remains of an exhauſted kettle of the ſame dye, the ſuperfluous dye being each time expreſſed; and after this proceſs they are dipped in the freſh dye prepared as above, which muſt not be expreſſed. The ſkins are then hung up in the ſhade to dry; after which they are cleaned and paired at the edges.

" For black ſhagreen, gall nuts and vitriol are employed in the following manner:—The ſkins, moiſt from the pickle, are thickly beſtrewed with finely pulverized gall nuts. They are then folded together, and laid over each other for 24 hours. A new ley, of bitter ſaline earth or *ſckora*, is in the mean time prepared, and poured hot into ſmall troughs. In this ley each ſkin is ſeveral times dipped; after which they are again beſtrewed with pounded gall-nuts, and placed in heaps for a certain period, that the galls may thoroughly penetrate them, and they are dried and beat, to free them from the duſt of the galls. When this is done, they are rubbed over, on the ſhagreen ſide, with melted ſheep's tallow, and expoſed a little in the ſun, that they may imbibe the greaſe. The ſhagreen makers are accuſtomed alſo to roll up each ſkin ſeparately, and to preſs or ſqueeze it with their hands againſt ſome hard ſubſtance, in order to promote the abſorption of the tallow. The ſuperfluous particles are removed by means of a blunt wooden ſcraper (*urac*); and when this proceſs is finiſhed, and the ſkins have lain ſome time, a ſufficient quantity of vitriol of iron is diſſolved in water, with which the ſhagreen is moiſtened on both ſides, and by this operation it acquires a beautiful black dye. It is then dreſſed at the edges, and in other places where there are any blemiſhes.

" To obtain white ſhagreen, the ſkins muſt firſt be moiſtened on the ſhagreen ſide with a ſtrong ſolution of alum. When the ſkin has imbibed this liquor, it is daubed over on both ſides with a paſte made of flour, which is ſuffered to dry. The paſte is then waſhed off with alum water, and the ſkin is placed in the ſun till it is completely dry. As ſoon as it is dry, it is gently beſmeared with pure melted ſheep's tallow, which it is ſuffered to imbibe in the ſun; and to promote the effect, it is preſſed and worked with the hands. The ſkins are then faſtened in ſucceſſion to the before-mentioned bench, where warm water is poured over them, and the ſuperfluous fat is ſcraped off with a blunt wooden inſtrument. In the laſt operation the warm water is of great ſervice. In this manner ſhagreen perfectly white is obtained, and nothing remains but to pare the edges and dreſs it.

" But this white ſhagreen is not intended ſo much for remaining in that ſtate, as for receiving a dark red dye; becauſe, by the above previous proceſs, the colour becomes much more perfect. The ſkins deſtined for a red colour muſt not be immerſed firſt in ley of bitter ſalt earth (*ſchora*), and then in pickle, but after they have been whitened, muſt be left to ſoak in the pickle for 24 hours. The dye is prepared from cochineal, which the Tartars call *kirmitz*. About a pound of the dried herb *tſchagann*, which grows in great abundance in the neighbourhood of Aſtracan, and is a kind of of soda plant or kali (*salsola ericoides*) (A), is boiled a full hour in a kettle containing about four common pailfuls of water; by which means the water acquires a greenish colour. The herb is then taken out, and about half a pound of pounded cochineal is put into the kettle, and the liquor is left to boil a full hour, care being taken to stir it that it may not run over. About 15 or 20 drams of a substance which the dyers call *lüter* (orchilla) is added, and when the liquor has been boiled for some time longer, the kettle is removed from the fire. The skins taken from the pickle are then placed over each other in troughs, and the dye-liquor is poured over them four different times, and rubbed into them with the hands, that the colour may be equally imbibed and diffused. The liquor each time is expressed; after which they are fit for being dried. Skins prepared in this manner are sold at a much dearer rate than any of the other kinds."

SHAIK properly signifies an old man. In the east it is used to denote a lord or chief, a man of eminence and property. See SCHIECHS.

SHAKE, in singing. See TRILL.

SHAKESPEARE or SHAKSPEARE, *William*, the prince of dramatic writers, was born at Stratford upon Avon in Warwickshire, on the 23d of April 1564. From the register of that town, it appears that a plague broke out there on the 30th of June following, which raged with great violence; but fortunately it did not reach the house in which this infant prodigy lay. His father, John Shakespeare, enjoyed a small patrimonial estate, and was a considerable dealer in wool; his mother was the daughter and heir of Robert Arden of Wellingcote. Our illustrious poet being designed for the business of his father, received no better education than the instructions which the free-school of Stratford could afford. After applying some time to the study of Latin, he was called home to assist his father, who seems by some accident to have been reduced in his circumstances. Before arriving at the age of 19, he married the daughter of Mr Hathaway, a substantial yeoman in the neighbourhood of Stratford. This lady was eight years older than her husband. Having the misfortune to fall into bad company, he was seduced into some profligate actions, which drew on him a criminal prosecution, and at length forced him to take refuge in the capital. In concert with his associates, he broke into a park belonging to Sir Thomas Lucy of Charlecote, and carried off some of his deer. Every admirer of Shakespeare will regret that such a blemish should have stained his character; but, perhaps, if any thing can extenuate his guilt, we might ascribe it to the opinions of the age, which, perhaps, as was formerly the case in Scotland, might not distinguish the killing of deer by any mark of disgrace, or any charge of criminality. One thing at least is certain, that Shakespeare himself thought that the prosecution which Sir Thomas raised against him was carried on with too great severity; an opinion which he could not have entertained had this action been at that time viewed in the same criminal light as it is at present. Shakespeare testified his resentment against Sir Thomas, by writing a satirical ballad, which exasperated him so much, that the process was carried on with redoubled violence; and the young poet, in order to avoid the punishment of the law, was obliged to make his escape. This ballad would be considered as a curious relick, on account of its being the first production of Shakespeare; it would also be interesting to peruse a poem which could irritate the baronet to so high a degree. Tradition has preserved the first stanza:

A parliamente member, a justice of peace,
At home a poor scare-crow, at London an asse.
If lowsie is Lucy, as some volke miscalle it,
Then Lucy is lowsie whatever befall it:
He thinks himself greate,
Yet an asse in his state,
We allowe by his ears, but with asses to mate.
If Lucy is lowsie, as some volke miscalle it,
Sing lowsie Lucy whatever befall it.

If the rest of the ballad was of a piece with this stanza, it might assist us to form some opinion of the irritability of the baronet, but will enable us to form no idea of the opening genius of Shakespeare.

Thus expelled from his native village, he repaired to London, where he was glad to accept a subordinate office in the theatre. It has been said that he was first engaged, while the play was acting, in holding the horses of those who rode to the theatre; but this story rests on a slender foundation. As his name is found printed among those of the other players before some old plays, it is probable that he was some time employed as an actor; but we are not informed what characters he played; we are only told, that the part which he acted best was that of the Ghost in Hamlet; and that he appeared in the character of Adam in *As you like it*. If the names of the actors prefixed to Ben Jonson's play of *Every Man in his Humour* were arranged in the same order as the persons represented, which is very probable, Shakespeare played the part of Old Knowell. We have reason therefore to suppose, as far as we can argue from these few facts, that he generally represented old men. See Malone's Chronology, in his edition of Shakespeare.

But though he was not qualified to shine as an actor, he was now in the situation which could most effectually rouse those latent sparks of genius which afterwards burst forth with so resplendent a flame. Being well acquainted with the mechanical business of the theatre and the taste of the times; possessed of a knowledge of the characters of men resembling intuition, an imagination that ranged at large through nature, selecting the grand, the sublime, and the beautiful; a judicious caution, that disposed him to prefer those plots which had already been found to please; an uncommon fluency

(A) The beautiful red Turkey leather is dyed with cochineal prepared in the same manner. Professor Gmelin junior, in the second part of his Travels through Russia, explains the herb *tschagann* by *artemisia annua*, having doubtless been deceived by the appearance the plant acquires after it has been dried. Besides, this *artemisia* is found only in the middle of Siberia, and never on the west side of the Irtisch.

Shakespeare.

fluency and force of expression; he was qualified at once to eclipse all who had gone before him.

Notwithstanding the unrivalled genius of Shakespeare, most of his plots were the invention of others; which, however, he certainly much improved, if he did not entirely new-model. We are assured, that prior to the theatrical compositions of Shakespeare, dramatic pieces were written on the following subjects, viz. King John, King Richard II. and III. King Henry IV. and V. King Henry VIII. King Lear, Antony and Cleopatra, Measure for Measure, the Merchant of Venice, the Taming of a Shrew, and the Comedy of Errors.

Among his patrons, the earl of Southampton is particularly honoured by him, in the dedication of two poems, Venus and Adonis, and Lucrece; in the latter especially, he expressed himself in such terms as gives countenance to what is related of that patron's distinguished generosity to him. In the beginning of King James I.'s reign (if not sooner) he was one of the principal managers of the playhouse, and continued in it several years afterwards; till, having acquired such a fortune as satisfied his moderate wishes and views in life, he quitted the stage, and all other business, and passed the remainder of his time in an honourable ease, at his native town of Stratford, where he lived in a handsome house of his own purchasing, to which he gave the name of *New Place;* and he had the good fortune to save it from the flames in the dreadful fire that consumed the greatest part of the town in 1614.

In the beginning of the year 1616, he made his will, wherein he testified his respect to his quondam partners in the theatre: he appointed his youngest daughter, jointly with her husband, his executors, and bequeathed to them the best part of his estate, which they came into the possession of not long after. He died on the 23d of April following, being the 53d year of his age; and was interred among his ancestors on the north side of the chancel, in the great church of Stratford, where there is a handsome monument erected for him, inscribed with the following elegiac distich in Latin:

Judicio Pylium, genio Socratem, arte Maronem,
Terra tegit, Populus mæret, Olympus habet.

In the year 1740, another very noble one was raised to his memory, at the public expence, in Westminster abbey; an ample contribution for this purpose being made upon exhibiting his tragedy of Julius Cæsar, at the theatre-royal in Drury-Lane, April 28th 1738.

Nor must we omit mentioning another testimony of the veneration paid to his manes by the public in general, which is, that a mulberry-tree planted upon his estate by the hands of this revered bard, was cut down not many years ago; and the wood being converted to several domestic uses, was all eagerly bought at a high price, and each single piece treasured up by its purchaser as a precious memorial of the planter.

The character of Shakespeare as a dramatic writer has been often drawn, but perhaps never with more accuracy than by the pen of Dr Johnson: "Shakespeare (says he) is above all writers, at least above all modern writers, the poet of nature; the poet that holds up to his readers a faithful mirror of manners and of life. His characters are not modified by the customs of particular places, unpractised by the rest of the world; by the peculiarities of studies or professions, which can operate but upon small numbers; or by the accidents of transient fashions or temporary opinions: they are the genuine progeny of common humanity, such as the world will always supply, and observation will always find. His persons act and speak by the influence of those general passions and principles by which all minds are agitated, and the whole system of life is continued in motion. In the writings of other poets, a character is too often an individual; in those of Shakespeare, it is commonly a species.

"It is from this wide extension of design that so much instruction is derived. It is this which fills the plays of Shakespeare with practical axioms and domestic wisdom. It was said of Euripides, that every verse was a precept; and it may be said of Shakespeare, that from his works may be collected a system of civil and economical prudence. Yet his real power is not shown in the splendor of particular passages, but by the progress of his fable, and the tenor of his dialogue; and he that tries to recommend him by select quotations, will succeed like the pedant in Hierocles, who, when he offered his house to sale, carried a brick in his pocket as a specimen.

"Upon every other stage the universal agent is love, by whose power all good and evil is distributed, and every action quickened or retarded. But love is only one of many passions; and as it has no great influence upon the sum of life, it has little operation in the dramas of a poet who caught his ideas from the living world, and exhibited only what he saw before him. He knew that any other passion, as it was regular or exorbitant, was a cause of happiness or calamity.

"Characters thus ample and general were not easily discriminated and preserved; yet perhaps no poet ever kept his personages more distinct from each other.

"Other dramatists can only gain attention by hyperbolical or aggravated characters, by fabulous and unexampled excellence or depravity, as the writers of barbarous romances invigorated the reader by a giant and a dwarf; and he that should form his expectations of human affairs from the play, or from the tale, would be equally deceived. Shakespeare has no heroes, his scenes are occupied only by men, who act and speak as the reader thinks that he should himself have spoken or acted on the same occasion: Even where the agency is supernatural, the dialogue is level with life. Other writers disguise the most natural passions and most frequent incidents; so that he who contemplates them in the book will not know them in the world: Shakespeare approximates the remote, and familiarizes the wonderful; the event which he represents will not happen, but if it were possible, its effects would probably be such as he has assigned; and it may be said, that he has not only shown human nature as it acts in real exigencies, but as it would be found in trials to which it cannot be exposed.

"This therefore is the praise of Shakespeare, that his drama is the mirror of life; that he who has mazed his imagination, in following the phantoms which other writers raise up before him, may here be cured of his delirious ecstasies, by reading human sentiments in human language: by scenes from which a hermit may esti-

Shakespeare. mate the transactions of the world, and a confessor predict the progress of the passions."

The learning of Shakespeare has frequently been a subject of inquiry. That he possessed much classical knowledge does not appear, yet he was certainly acquainted with the Latin poets, particularly with Terence, as Colman has justly remarked, which appears from his using the word *thrasonical*. Nor was he unacquainted with French and Italian. We are indeed told, that the passages in which these languages occur might be impertinent additions of the players; but is it probable, that any of the players so far surpassed Shakespeare?

That much knowledge is scattered over his works is very justly observed by Pope; but it is often such knowledge as books did not supply. "There is, however, proof enough (says Dr Johnson) that he was a very diligent reader; nor was our language then so indigent of books, but that he might very liberally indulge his curiosity without excursion into foreign literature. Many of the Roman authors were translated, and some of the Greek; the Reformation had filled the kingdom with theological learning; most of the topics of human disquisition had found English writers; and poetry had been cultivated, not only with diligence, but success. This was a stock of knowledge sufficient for a mind so capable of appropriating and improving it."

The works of Shakespeare consist of 35 dramatic pieces. The following is the chronological order which Mr Malone has endeavoured to establish, after a minute investigation, in which he has in general been successful:

1. First Part of King Henry VI. -	1589
2. Second Part of King Henry VI. -	1591
3. Third Part of King Henry VI. -	1591
4. A Midsummer Night's Dream -	1592
5. Comedy of Errors - -	1593
6. Taming of the Shrew - -	1594
7. Love's Labour Lost - -	1594
8. Two Gentlemen of Verona -	1595
9. Romeo and Juliet - -	1595
10. Hamlet - -	1596
11. King John - -	1596
12. King Richard II. - -	1597
13. King Richard III. - -	1597
14. First Part of King Henry IV. -	1597
15. Second Part of King Henry IV. -	1598
16. The Merchant of Venice - -	1598
17. All's Well that Ends Well -	1598
18. King Henry V. - -	1599
19. Much Ado about Nothing -	1600
20. As you like it - -	1600
21. Merry Wives of Windsor -	1601
22. King Henry VIII. - -	1601
23. Troilus and Cressida - -	1602
24. Measure for Measure - -	1603
25. The Winter's Tale - -	1604
26. King Lear - -	1605
27. Cymbelline - - -	1605
28. Macbeth - - -	1606
29. Julius Cæsar - -	1607
30. Antony and Cleopatra - -	1608
31. Timon of Athens - -	1609
32. Coriolanus - -	1610
33. Othello - -	1611
34. The Tempest - -	1612
35. Twelfth Night - -	1614

The first three of these, Mr Malone thinks, there is very strong reason to believe are not the original productions of Shakespeare; but that he probably altered them, and added some new scenes.

In the first folio edition in 1623, these plays were entitled "Mr William Shakespeare's Comedies, Histories, and Tragedies." They have been published by various editors. The first folio edition by Isaac Jaggard and Edward Blount; the second, folio, 1632, by Thomas Cotes for Robert Allot; the third, 1664, for P. C.; the fourth, 1685, for H. Herringman, E. Brewster, and R. Bentley. Rowe published an 8vo edition in 1709, in 7 vols, and a 12mo edition in 1714, in 9 vols; for which he received 36l. 10s. Pope published a 4to edition in 1725, in 6 vols, and a 12mo in 1728, in 10 vols; for which he was paid 217l. 12s. Theobald gave a new edition in 8vo in 1733, in 7 vols, another in 12mo in 1740, in 8 vols; and received for his labour 652l. 10s. Sir Thomas Hanmer published an edition in 1744, in 6 vols 4to. Dr Warburton's 8vo edition came out in 1747, in 8 vols; for which he was paid 560l. The editions published since that time, are Dr Johnson's in 1765, in 8 vols 8vo. Stevens's in 1766, in 4 vols 8vo. Capell's in 1768, in 10 vols, crown 8vo; for this the author was paid 300l. A second edition of Hanmer's in 1771, 6 vols. Johnson's and Stevens's in 1773, in 10 vols 8vo; a second edition in 1778; a third by Reed in 1785; and Malone's crown 8vo edition in 1789, in 10 vols.

The most authentic of the old editions is that of 1623. "At last (says Dr Johnson) an edition was undertaken by Rowe; not because a poet was to be published by a poet, for Rowe seems to have thought very little on correction or explanation, but that our author's works might appear like those of his fraternity, with the appendages of a life and recommendatory preface. Rowe has been clamorously blamed for not performing what he did not undertake; and it is time that justice be done him, by confessing, that though he seems to have had no thought of corruption beyond the printer's errors, yet he has made many emendations, if they were not made before, which his successors have received without acknowledgment, and which, if they had produced them, would have filled pages with censures of the stupidity by which the faults were committed, with displays of the absurdities which they involved, with ostentatious expositions of the new reading, and self-congratulations on the happiness of discovering it."

The nation had been for many years content enough with Mr Rowe's performance, when Mr Pope made them acquainted with the true state of Shakespeare's text, showed that it was extremely corrupt, and gave reason to hope that there were means of reforming it. Mr Pope's edition, however, he observes, fell below his own expectations; and he was so much offended, when he was found to have left any thing for others to do, that he passed the latter part of his life in a state of hostility with verbal criticism.

The only task, in the opinion of Mr Malone, for which Pope was eminently and indisputably qualified, was

was to mark the faults and beauties of his author.—When he undertook the office of a commentator, every anomaly of language, and every expression that was currently in use, were considered as errors or corruptions, and the text was altered or amended, as it was called, at pleasure. Pope is openly charged with being one of the great corrupters of Shakespeare's text.

Pope was succeeded by Theobald, who collated the ancient copies, and rectified many errors. He was, however, a man of narrow comprehension and of little learning, and what is worse, in his reports of copies and editions, he is not to be trusted without examination. From the liberties taken by Pope, the edition of Theobald was justly preferred, because he professed to adhere to the ancient copies more strictly, and illustrated a few passages by extracts from the writers of our poet's age. Still, however, he was a considerable innovator; and while a few arbitrary changes made by Pope were detected, innumerable sophistications were silently adopted.

Sir Thomas Hanmer, who comes next, was a man of critical abilities, and of extensive learning. His corrections are commonly just, but sometimes capricious. He is censurable, too, for receiving without examination almost all the innovations of Pope.

The original and predominant error of Warburton's commentary, is acquiescence in his first thoughts; that precipitation which is produced by consciousness of quick discernment; and that confidence which presumes to do, by surveying the surface, what labour only can perform, by penetrating to the bottom. His notes exhibit sometimes perverse interpretations, and sometimes improbable conjectures; he at one time gives the author more profundity of meaning than the sentence admits, and at another discovers absurdities where the sense is plain to every other reader. But his emendations are likewise often happy and just; and his interpretation of obscure passages learned and sagacious.

It has indeed been said by his defenders, that his great object was to display his own learning; and certainly, in spite of the clamour raised against him for substituting his own chimerical conceits instead of the genuine text of Shakespeare, his work increased his reputation. But as it is of little value as a commentary on Shakespeare, since Warburton is now gone, his work will probably soon sink into oblivion.

In 1765 Dr Johnson's edition, which had long been impatiently expected, was given to the public. His vigorous and comprehensive understanding threw more light on his author than all his predecessors had done. The character which he gave of each play is generally just. His refutation of the false glosses of Theobald and Warburton, and his numerous explications of involved and difficult passages, entitle him to the gratitude of every admirer of Shakespeare.

The last editor is Mr Malone, who was eight years employed in preparing his edition. By collating the most authentic copies, he has been careful to purify the text. He has been so industrious, in order to discover the meaning of the author, that he has ransacked many volumes, and trusts that, besides his additional illustrations, not a single valuable explication of any obscure passage in these plays has ever appeared, which he has not inserted in his edition. He rejects Titus Andronicus, as well as the three plays formerly mentioned, as not being the authentic productions of Shakespeare. To the whole he has added an appendix, and a copious glossary.—Of this work a less expensive edition has been published in 7 vols 12mo, in which the general introductory observations prefixed to the different plays are preserved, and the numerous notes abridged.

This judicious commentator has certainly done more for the elucidation and correction of Shakespeare than all who came before him, and has followed with indefatigable patience the only road which a commentator of Shakespeare ought to observe.

Within 50 years after our poet's death, Dryden says that he was become "a little obsolete;" and in the beginning of the 18th century Lord Shaftesbury complains of his rude unpolished style, and his antiquated phrase and wit. These complaints were owing to the great revolution which the English language has undergone, and to the want of an enlightened commentator. These complaints are now removed, for an enlightened commentator has been found in Mr Malone.

We have only farther to add, that in the year 1790 a copious index to the remarkable passages and words in the plays of Shakespeare was published by the Reverend Mr Ayscough; a gentleman to whom the literary world is much indebted for several very valuable keys of knowledge. In fine, the admirers of Shakespeare are now, by the labours of several eminent men, furnished with every help that can enable them to understand the sense and to taste the beauties of this illustrious poet.

SHAKLES. See SHACKLES.

SHALE, in MINERALOGY, a kind of SCHISTUS, of a black colour and slaty structure, or a clay hardened into a stony consistence, and so much impregnated with bitumen that it becomes somewhat like a coal. The acid emitted from shale, during its calcination, uniting itself to the argillaceous earth of the shale, forms alum. About 120 tons of calcined shale will make one ton of alum. The shale, after being calcined, is steeped in water, by which means the alum, which is formed during the calcination of the shale, is dissolved: this dissolved alum undergoes various operations before it is formed into the alum of the shops. Watson's Chemical Essays, vol. ii. p. 315. See ALUM, CHEMISTRY *Index*.

This kind of slate forms large strata in Derbyshire; and that which lies near the surface of the earth is of a softer and more shivery texture than that which lies deeper. It is also found in large strata, generally above the coal, in most coal counties of this kingdom.

SHALLOP, SHALLOOP, or SLOOP, is a small light vessel, with only a small main-mast and fore-mast, and lug-sails, to haul up, and let down, on occasion.—Shallops are commonly good sailers, and are therefore often used as tenders upon men of war.

SHALLOT, or ESCHALOT. See ALLIUM, BOTANY and GARDENING *Index*.

SHAMANS are wizards or conjurers, in high repute among several idolatrous nations inhabiting different parts of Russia. By their enchantments they pretend to cure diseases, to divert misfortunes, and to foretel futurity. They are great observers of dreams, by the interpretation of which they judge of their good or bad fortune. They pretend likewise to chiromancy, and to foretel a man's good or ill success by the lines of his

his hand. By these and such like means they have a very great ascendancy over the understandings, and a great influence on the conduct, of those people.

SHAMBLES, among miners, a sort of niches or landing places, left at such distances in the adits of the mines, that the shovel-men may conveniently throw up the ore from shamble to shamble, till it comes to the top of the mine.

SHAMOIS, CHAMOIS, or SHAMMY, a kind of leather, either dressed in oil or tanned, much esteemed for its softness, pliancy, &c. It is prepared from the skin of the chamois, or shamois, a kind of rupicapra, or wild goat, called also isard, inhabiting the mountains of Dauphiny, Savoy, Piedmont, and the Pyrenees. Besides the softness and warmth of the leather, it has the faculty of bearing soap without damage; which renders it very useful on many accounts.

In France, &c. some wear the skin raw, without any preparation. Shammy leather is used for the purifying of mercury, which is done by passing it through the pores of this skin, which are very close. The true chamois leather is counterfeited with common goat, kid, and even with sheep skins, the practice of which makes a particular profession, called by the French *chamoisure*. The last, though the least esteemed, is yet so popular, and such vast quantities of it are prepared, especially about Orleans, Marseilles, and Tholouse, that it may be proper to give the method of preparation.

Manner of shamoising, or of preparing sheep, goat, or kid skins in oil, in imitation of shammy.—The skins, being washed, drained, and smeared over with quicklime on the fleshy side, are folded in two lengthwise, the wool outwards, and laid in heaps, and so left to ferment eight days, or, if they had been left to dry after flaying, then fifteen days.

Then they are washed out, drained, and half dried; laid on a wooden leg, or horse, the wool stripped off with a round staff for that purpose, and laid in a weak pit, the lime whereof had been used before, and has lost the greatest part of its force.

After 24 hours they are taken out, and left to drain 24 more; they are then put in another stronger pit. This done, they are taken out, drained, and put in again, by turns; which begins to dispose them to take oil; and this practice they continue for six weeks in summer, or three months in winter: at the end whereof they are washed out, laid on the wooden leg, and the surface of the skin on the wool side peeled off, to render them the softer; then made into parcels, steeped a night in the river, in winter more, stretched six or seven over one another on the wooden leg, and the knife passed strongly on the flesh side, to take off any thing superfluous, and render the skin smooth. Then they are steeped, as before, in the river, and the same operation is repeated on the wool side; they are then thrown into a tub of water, with bran in it, which is brewed among the skins till the greatest part sticks to them, and then separated into distinct tubs, till they swell, and rise of themselves above the water. By this means the remains of the lime are cleared out; they are then wrung out, hung up to dry on ropes, and sent to the mill, with the quantity of oil necessary to scour them: the best oil is that of stock-fish. Here they are first thrown in bundles into the river for 12 hours, then laid in the mill-trough, and fulled without oil till they be well softened; then oiled with the hand, one by one, and thus formed into parcels of four skins each; which are milled and dried on cords a second time; then a third; and then oiled again, and dried. This process is repeated as often as necessity requires; when done, if there be any moisture remaining, they are dried in a stove, and made up into parcels wrapped up in wool; after some time they are opened to the air, but wrapped up again as before, till such time as the oil seems to have lost all its force, which it ordinarily does in 24 hours. The skins are then returned from the mill to the chamoiser to be scoured; which is done by putting them in a lixivium of wood-ashes, working and beating them in it with poles, and leaving them to steep till the ley hath had its effect; then they are wrung out, steeped in another lixivium, wrung again; and this is repeated till all the grease and oil be purged out. When this is done, they are half dried, and passed over a sharp-edged iron instrument, placed perpendicular in a block, which opens, softens, and makes them gentle. Lastly, they are thoroughly dried, and passed over the same instrument again; which finishes the preparation, and leaves them in form of shammy.

Kid and goat skins are shamoised in the same manner as those of sheep, excepting that the hair is taken off without the use of any lime; and that when brought from the mill they undergo a particular preparation called *ramalling*, the most delicate and difficult of all the others. It consists in this, that, as soon as brought from the mill, they are steeped in a fit lixivium, taken out, stretched on a round wooden leg, and the hair is scraped off with the knife; this makes them smooth, and in working to cast a kind of fine knap. The difficulty is in scraping them evenly.

SHANK, or *SHANK-Painter*, in a ship, is a short chain fastened under the foremast shrouds, by a bolt, to the ship's sides, having at the other end a rope fastened to it. On this shank-painter the whole weight of the aft part of the anchor rests, when it lies by the ship's side. The rope, by which it is hauled up, is made fast about a timber head.

SHANK, in the manege, that part of a horse's fore leg which lies between the knee and the fetlock.

SHANKER, or CHANCRE, in *Medicine*, a malignant ulcer, usually occasioned by some venereal disorder. See MEDICINE, N° 350.

SHANNON, the largest river in Ireland, and one of the finest in the British dominions, not only on account of its rolling 200 miles, but also of its great depth in most places, and the gentleness of its current, by which it might be made exceedingly serviceable to the improvement of the country, the communication of its inhabitants, and consequently the promoting of inland trade, through the greatest part of its long course. But the peculiar prerogative of the Shannon is its situation, running from north to south, and separating the province of Connaught from Leinster and Munster, and of consequence dividing the greatest part of Ireland into what lies on the east and that on the west of the river; watering in its passage the valuable county of Leitrim, the plentiful shire of Roscommon, the fruitful county of Galway, and the pleasant county of Clare; the small but fine shire of Longford, the King's county, and fertile county of Meath in Leinster, the populous county of Tipperary, the spacious shire of Limerick,

rick, and the rough but pleasant county of Kerry in Munster; visiting 10 counties in its passage, and having on its banks the following remarkable places, viz. Leitrim, Jamestown, Lanesborough, Athlone, Clonfert, Killaloe, and Limerick; at 20 leagues below the latter it spreads gradually several miles in extent, so that some have considered its expansion as a lake. It at last joins its waters to the sea, being navigable all that way for the largest vessels.

SHANSCRIT, the language of the Bramins of Hindostan. See Philology, sect. v.

SHARE *of a Plough*, that part which cuts the ground; the extremity forwards being covered with a sharp-pointed iron, called the *point of the share*, and the end of the wood behind the *tail of the share*.

SHARK. See Squalus, Ichthyology *Index*.

SHARON, a name common to three cantons of Palestine. The first lay between Mount Tabor and the sea of Tiberias; the second between the city of Cæsarea of Palestine, and Joppa; and the third lay beyond Jordan. To give an idea of perfect beauty, Isaiah said, the glory of Lebanon and the beauty of Carmel must be joined to the abundance of Sharon. (Isaiah xxxiii. 9. xxxi. 2.). The plains of Sharon are of vast extent; and, when surveyed by the Abbé Mariti a few years ago, they were sown with cucumbers; and he informs us, that such a number is annually produced, as not only to supply the whole neighbourhood, but also all the coasts of Cyprus and the city of Damietta. In the middle of the plain, between Arsus and Lydda, rises a small mountain, upon the ridge of which there is a small village called Sharon, from the name of the ancient city whose king was conquered by Joshua.

SHARP, James, archbishop of St Andrew's, was born of a good family in Banffshire in 1618. He devoted himself very early to the church, and was educated for that purpose in the university of Aberdeen. When the solemn league and covenant was framed in 1638, the learned men in that seminary, and young Sharp in particular, declared themselves decidedly against it. To avoid the insults and indignities to which he was subjected in consequence of this conduct, he retired to England, where he contracted an acquaintance with some of the most celebrated divines in that country.

At the commencement of the civil wars he returned to Scotland. During his journey thither, he accidentally met with Lord Oxenford, who was so charmed with his conversation, that he invited him to his house. While he resided with that nobleman, he became known to the earl of Rothes, who procured him a professorship at St Andrew's. By the interest of the earl of Crawford he was soon after appointed minister of Crail; where he conducted himself, it is said, in an exemplary manner.

Sharp had always inclined to the cause of royalty, and had for some time kept up a correspondence with his exiled prince. After the death of the protector he began to declare himself more openly, and seems to have enjoyed a great share of the confidence of Monk, who was at that time planning the restoration of Charles II. When that general marched to London, the presbyterians sent Sharp to attend him in order to support their interests. At the request of General Monk and the chief presbyterians in Scotland, Mr Sharp was sent over to the king at Breda to procure from him, if possible, the establishment of presbyterianism. On his return, he assured his friends that "he had found the king very affectionate to Scotland, and resolved not to wrong the settled government of the church: but he apprehended they were mistaken who went about to establish the presbyterian government."

Charles was soon after restored without any terms. All the laws passed in Scotland since the year 1633 were repealed; the king and his ministers resolved at all hazards to restore prelacy. Mr Sharp, who had been commissioned by the Scotch presbyterians to manage their interests with the king, was prevailed upon to abandon the party; and, as a reward for his compliance, he was made archbishop of St Andrew's. This conduct rendered him very odious in Scotland; he was accused of treachery and perfidy, and reproached by his old friends as a traitor and renegado. The absurd and wanton cruelties which were afterwards committed, and which were imputed in a great measure to the archbishop, rendered him still more detested. Nor is it probable that these accusations were without foundation: the very circumstance of his having been formerly of the presbyterian party would induce him, after forsaking them, to treat them with severity. Besides, it is certain, that when after the rout at Pentland-hills he received an order from the king to stop the executions, he kept it for some time before he produced it to council.

There was one Mitchell a preacher, and a desperate fanatic, who had formed the design of taking vengeance for these cruelties by assassinating the archbishop. He fired a pistol at him as he was sitting in his coach; but the bishop of Orkney, lifting up his hand at the moment, intercepted the ball. Though this happened in the midst of Edinburgh, the primate was so much detested, that nobody stopped the assassin; who, having walked leisurely home, and thrown off his disguise, returned, and mixed unsuspected with the crowd. Some years after, the archbishop observing a man eyeing him with keenness, suspected that he was the assassin, and ordered him to be brought before him. It was Mitchell. Two loaded pistols were found in his pocket. The primate offered him a pardon if he would confess the crime; the man complied; but Sharp, regardless of his promise, conducted him to the council. The council also gave him a solemn promise of pardon if he would confess his guilt, and discover his accomplices. They were much disappointed to hear that only one man was privy to his purpose, who was since dead. Mitchell was then brought before a court of justice, and ordered to make a third confession, which he refused. He was imprisoned for several years, and then tried. His own confession was urged against him. It was in vain for him to plead the illegality of that evidence, and to appeal to the promise of pardon previously given. The council took an oath that they had given no such promise; and Mitchell was condemned. Lauderdale, who at that time governed Scotland, would have pardoned him, but the primate insisted on his excution; observing, that if assassins were permitted to go unpunished, his life must be continually in danger. Mitchell was accordingly executed.

Sharp had a servant, one Carmichael, who by his cruelty had rendered himself particularly odious to the zealots. Nine men formed the resolution of waylaying him in Magus-moor, about three miles from St Andrew's.

Sharp. drew's. While they were waiting for this man, the primate himſelf appeared with very few attendants. This they looked upon as a declaration of heaven in their favour; and calling out, "the Lord has delivered him into our hands," they ran up to the carriage. They fired at him without effect; a circumſtance which was afterwards imputed to magic. They then diſpatched him with their ſwords, regardleſs of the tears and intreaties of his daughter, who accompanied him (A).

Thus fell Archbiſhop Sharp, whoſe memory is even at preſent deteſted by the common people of Scotland. His abilities were certainly good, and in the early part of his life he appears with honour and dignity. But his conduct afterwards was too cruel and inſincere to merit approbation. His treatment of Mitchell was mean and vindictive. How far he contributed to the meaſures adopted againſt the preſbyterians is not certain. They were equally cruel and impolitic; nor did their effects ceaſe with the meaſures themſelves. The unheard-of cruelties exerciſed by the miniſters of Cha. II. againſt the adherents of the covenant, raiſed ſuch a flame of enthuſiaſm and bigotry as is not yet entirely extinguiſhed.

Sharp, *Dr John*, archbiſhop of York, was deſcended from the Sharps of Little Norton, a family of Bradford Dale in Yorkſhire; and was ſon of an eminent tradeſman of Bradford, where he was born in 1644. He was educated at Cambridge, and in 1667 entered into orders. That ſame year he became domeſtic chaplain to Sir Heneage Finch, then attorney-general. In 1672 he was collated to the archdeaconry of Berkſhire. In 1675 he was inſtalled a prebendary in the cathedral church of Norwich; and the year following was inſtituted into the rectory of St Bartholomew near the Royal Exchange, London. In 1681 he was, by the intereſt of his patron Sir Heneage Finch, then lord high chancellor of England, made dean of Norwich; but in 1686 was ſuſpended for taking occaſion, in ſome of his ſermons, to vindicate the doctrine of the church of England in oppoſition to Popery. In 1688 he was ſworn chaplain to King James II. being then probably reſtored after his ſuſpenſion for it is certain that he was chaplain to King Charles II. and attended as a court chaplain at the coronation of King James II. In 1689 he was declared dean of Canterbury; but never could be perſuaded to fill up any of the vacancies made by the deprived biſhops. Upon the death of Dr Lamplugh, he was promoted to the ſee of York. In 1702 he preached the ſermon at the coronation of Queen Anne; and the ſame year was ſworn of the privy-council, and made lord almoner to her majeſty. He died at Bath in 1713; and was interred in the cathedral of York, where a monument is erected to his memory.—His ſermons, which were collected after his death and publiſhed in 7 vols 8vo, are juſtly admired. Sharp.

Sharp, *Abraham*, an eminent Engliſh mathematician, and aſtronomer, was born at Little Horton, near Bradford, in the year 1651. He was put apprentice to a merchant at Mancheſter; but ſo ſtrongly was he inclined to the ſtudy of mathematics, that he ſoon found his ſituation both irkſome and diſagreeable. By the mutual conſent, therefore, of his maſter and himſelf, he quitted the buſineſs of a merchant. He then removed to Liverpool, where he wholly devoted himſelf to mathematical ſtudies, and where, for a ſubſiſtence, he taught writing and accounts.

Soon after this a merchant from London, in whoſe houſe the celebrated Mr Flamſteed then lodged, engaged Mr Sharp to be his book-keeper. With this eminent aſtronomer he ſoon contracted an intimate friendſhip, and by his recommendation he obtained a more profitable employment in the dock-yard of Chatham, where he continued till his friend and patron called him to his aſſiſtance. Mr Sharp was chiefly employed in the conſtruction of the mural arch, which he finiſhed in the courſe of 14 months ſo entirely to the ſatisfaction of Mr Flamſteed, that he ſpoke of him in terms of the higheſt praiſe. In the opinion of Mr Smeaton, this was the firſt good inſtrument of the kind, and Mr Sharp the firſt artiſt who cut delicate diviſions on aſtronomical inſtruments. When this inſtrument was conſtructed, Mr Sharp was but 25, and Mr Flamſteed 30 years of age. Mr Sharp aſſiſted his friend in making a catalogue of nearly 3000 fixed ſtars, with their longitudes and magnitudes, their right aſcenſions and polar diſtances, with the variations of the ſame while they change their longitude by one degree.

But from the fatigue of conſtantly obſerving the ſtars by night, in a cold thin air, added to a weakly conſtitution, his health was much impaired; for the recovery of which he requeſted leave to retire to his houſe at Horton, where, as ſoon as he felt himſelf recovering, he began to fit up an obſervatory of his own, and the teleſcopes he made uſe of were all of his own conſtruction, and the lenſes ground and adjuſted with his own hands.

It was about this time that he aſſiſted Mr Flamſteed in calculating moſt of the tables in the ſecond volume of his *Hiſtoria Cœleſtis*, as appears by their letters, to be ſeen in the hands of Mr Sharp's friends at Horton. The mathematician, ſays Dr Hutton, meets with ſomething extraordinary in Sharp's elaborate treatiſe of *Geometry Improved;* by a large and accurate table of ſegments of circles, its conſtruction and various uſes in the ſolution of ſeveral difficult problems, with compendious tables for finding a true proportional part; and their uſe in theſe or any other tables exemplified in making logarithms,

(A) Such is the account given by all our hiſtorians of the murder of Archbiſhop Sharp; and that he fell by the hands of fanatics, whom he perſecuted, is certain. A tradition, however, has been preſerved in different families deſcended from him, which may be mentioned, and is in itſelf certainly not incredible. The primate, it ſeems, who, when miniſter of Crail, was peculiarly ſevere in puniſhing the ſin of fornication, had, in the plenitude of his archiepiſcopal authority, taken notice of a criminal amour carried on between a nobleman high in office and a lady of ſome faſhion who lived within his dioceſe. This interference was in that licentious age deemed very impertinent; and the archbiſhop's deſcendants believe that the proud peer inſtigated the deluded rabble to murder their anceſtor.

logarithms, or their natural numbers, to 60 places of figures; there being a table of them for all primes to 1100, true to 61 figures. His concise treatise of Polyedra, or solid bodies of many bases, both of the regular ones and others; to which are added, 12 new ones, with various methods of forming them, and their exact dimensions in surds or species, and in numbers; illustrated with a variety of copper-plates, neatly engraved by his own hands. Indeed, few of the mathematical instrument makers could exceed him in exactly graduating or neatly engraving mathematical or astronomical instruments. He possessed a remarkably clear head for contriving, and an extraordinary hand for executing any thing, not only in mechanics, but likewise in drawing, writing, and making the most beautiful figures in all his calculations and constructions.

The quadrature of the circle was undertaken by him for his own amusement, in the year 1699, deduced from two different series, by which the truth of it was proved to 72 places of figures, as may be seen in Sherwin's Tables of Logarithms. In the same book may likewise be seen his ingenious improvements on the making of logarithms, and the constructing of the natural sines, tangents, and secants.

Mr Sharp kept up a correspondence with most of the eminent mathematicians and astronomers of his time, as Flamsteed, Newton, Halley, Wallis, Hodgson, &c. the answers to whose letters are all written on the backs or empty spaces, of the letters he received, in a short hand of his own invention. Being one of the most accurate and indefatigable computers whoever existed; he was many years the common resource for Flamsteed, Sir Jonas Moor, Halley, and others, in all sorts of troublesome and delicate calculations.

Mr Sharp was never married, and spent his time as a hermit. He was of a middle stature, very thin, of a weakly constitution; but remarkably feeble during the last 3 or 4 years before his death, which happened on the 18th of July 1742, in the 91st year of his age.

He was very irregular as to his meals, and uncommonly sparing in his diet, which he frequently took in the following manner. A little square hole, resembling a window, formed a communication between the room where he usually studied, and another where a servant could enter; and before this hole he had contrived a sliding board. It often happened, that the breakfast, dinner, and supper, have remained untouched, when the servant has gone to remove what was left,—so deeply was he engaged in calculations.

SHARP, in *Music*. See INTERVAL.

SHASTAH, the same as SHASTER.

SHASTER, SHASTAH, or BEDANG, the name of a sacred book, in high estimation among the idolaters of Hindostan, containing all the dogmas of the religion of the bramins, and all the ceremonies of their worship; and serving as a commentary on the VEDAM.

The term *Shaster* denotes "science" or "system"; and is applied to other works of astronomy and philosophy, which have no relation to the religion of the Indians. None but the bramins and rajahs of India are allowed to read the Vedam; the priests of the Banians, called *Shuderers*, may read the Shaster; and the people, in general, are allowed to read only the Paran or Pouran, which is a commentary on the Shaster.

The Shaster is divided into three parts: the first containing the moral law of the Indians; the second, the rites and ceremonies of their religion; and the third, the distribution of the people into tribes or classes, with the duties pertaining to each class.

The principal precepts of morality, contained in the first part of the Shaster, are the following: that no animal be killed, because the Indians attribute souls to brute animals as well as to mankind; that they neither hear nor speak evil, nor drink wine, nor eat flesh, nor touch any thing that is unclean; that they observe the feasts, prayers, and washings, which their law prescribes; that they tell no lies, nor be guilty of deceit in trade; that they neither oppress nor offer violence to one another; that they celebrate the solemn feasts and fasts, and appropriate certain hours of ordinary sleep to cultivate a disposition for prayer; and that they do not steal or defraud one another.

The ceremonies, contained in the second part of the Shaster, are such as these: that they wash often in the rivers, hereby obtaining the pardon of their sins; that they mark their forehead with red, in token of their relation to the Deity; that they present offerings and prayers under certain trees, set apart for this purpose; that they pray in the temples, make oblations to their pagodas or idols, sing hymns, and make processions, &c.; that they make pilgrimages to distant rivers, and especially to the Ganges, there to wash themselves and make offerings; that they make vows to particular saints, according to their respective departments; that they render homage to the Deity at the first sight of the sun; that they pay their respect to the sun and moon, which are the two eyes of the Deity; and that they treat with particular veneration those animals that are deemed more pure than others; as the cow, buffalo, &c.; because the souls of men have transmigrated into these animals.

The third part of the Shaster records the distribution of the people into four classes: the first being that of the bramins or priests, appointed to instruct the people; the second, that of the kutteris or nobles, who are the magistrates; the third, that of the shudderis or merchants; and the fourth, that of the mechanics. Each person is required to remain in the class in which he was born, and to pursue the occupation assigned to him by the Shaster. According to the bramins, the Shaster was imparted by God himself to Brahma, and by him to the bramins; who communicated the contents of it to the people.

Modern writers have given us very different accounts of the antiquity and importance of the Shaster. Mr Holwell, who had made considerable progress in the translation of this book, apprehends, that the mythology as well as the cosmogony of the Egyptians, Greeks, and Romans, was borrowed from the doctrines of the bramins, contained in it, even to the copying of their exteriors of worship, and the distribution of their idols, though grossly mutilated and adulterated. With respect to the Vedam and Shaster, or scriptures of the Gentoos, this writer informs us, that *Vedam*, in the Malabar language, signifies the same as *Shaster* in the Shanscrit; and that the first book is followed by the Gentoos of the Malabar and Coromandel coasts, and also of the island of Ceylon. The Shaster is followed by the Gentoos of the provinces of Bengal, and by all the Gentoos

Gentoos of the rest of India, commonly called *India Proper*, along the course of the rivers Ganges and Jumna to the Indus. Both these books (he says) contain the institutes of their respective religion and worship, as well as the history of their ancient rajahs and princes, often couched under allegory and fable. Their antiquity is contended for by the partisans of each; but he thinks, that the similitude of their names, idols, and great part of their worship, leaves little room to doubt, nay plainly evinces, that both these scriptures were originally one. He adds, if we compare the great purity and chaste manners of the Shaster with the great absurdities and impurities of the Vedam, we need not hesitate to pronounce the latter a corruption of the former.

With regard to the high original of these scriptures, the account of the bramins is as follows. Brahma (that is, "Mighty Spirit"), about 4866 years ago, assumed the form of man and the government of Indostan. He translated the divine law (designed for the restoration of mankind, who had offended in a pre-existent state, and who are now in their last scene of probation, to the dignity from which they were degraded) out of the language of angels into the well known Shanscrit language, and called his translation the *Chartah Bhade Shastah of Birmah*, or *the Six Scriptures of Divine Words of the Mighty Spirit*. He appointed the bramins, deriving their name from him, to preach the word of God; and the doctrines of the Shaster were accordingly preached in their original purity 1000 years. About this time there was published a paraphrase on the Chartah Bhade; and about 500 years afterwards, a second exposition, called the *Aughtorrah Bhade Shasta*, or *Eighteen Books of Divine Words*, written in a character compounded of the common Indostan and the Shanscrit. This innovation produced a schism among the Gentoos; on which occasion, it is said, those of Coromandel and Malabar formed a scripture of their own, which they pretended to be founded on the Chartah Bhade of Bramah, and called it *the Vedam of Birmah*, or *Divine Words of the Mighty Spirit*. The original Chartah Bhade was thrown aside, and at length wholly unknown, except to a few families; who can still read and expound it in the Shanscrit character. With the establishment of the Aughtorrah Bhade, and Vedam, which, according to the Gentoo account, is 3366 years ago, their polytheism commenced; and the principles of religion became so obscure, and their ceremonies so numerous, that every head of a family was obliged to keep a bramin as a guide both in faith and practice. Mr Holwell is of opinion, that the Chartah Bhade, or Original Scriptures, are not copied from any other system of theology, promulgated to or obtruded upon mankind. The Gentoos do not attribute them to Zoroaster; and Mr Holwell supposes, that both Zoroaster and Pythagoras visited Indostan, not to instruct, but to be instructed.

From the account of Mr Dow, we learn, that the books which contain the religion and philosophy of the Hindoos are distinguished by the name of *Bedas*; that they are four in number, and like the sacred writings of other nations, said to be penned by the Divinity. Beda, he says, in the Shanscrit language, literally signifies *science*; and these books treat not only of religion and moral duties, but of every branch of philosophic knowledge. The bramins maintain, that the Bedas are the divine laws, which Brimha, at the creation of the world, delivered for the instruction of mankind; but they affirm, that their meaning was perverted in the first age by the ignorance and wickedness of some princes, whom they represent as evil spirits, who then haunted the earth.

The first credible account we have of the Bedas is, that about the commencement of the Cal Jug, of which era the year 1768 was the 4886th year, they were written, or rather collected, by a great philosopher and reputed prophet, called *Beäss Muni*, or *Beäss the Inspired*.

The Hindoos (says Mr Dow) are divided into two great religious sects: the followers of the doctrine of Bedang, which is the original Shaster, or commentary upon the Bedas; and those who adhere to the principles of the Neadirsen. The original Shaster is called *Bedang*, and is a commentary upon the Bedas. This book, he says, is erroneously called in Europe the *Vedam*. It is ascribed to Beäss Muni, and is said to have been revised some years after by one Serrider Swami, since which it has been reckoned sacred, and not subject to any farther alterations.

Almost all the Hindoos of the Decan, and those of the Malabar and Coromandel coasts, are of this sect. The followers of the Bedang Shaster do not allow that any physical evil exists; they maintain that God created all things perfectly good; but that man, being a free agent, may be guilty of moral evil, which may be injurious to himself, but can be of no detriment to the general system of nature. God, they say, being perfectly benevolent, never punished the wicked otherwise than by the pain and affliction which are the natural consequences of evil actions; and hell, therefore, is no other than a consciousness of evil.

The Neadirsen Shaster is said to have been written by a philosopher called *Goutam*, near four thousand years ago. The bramins, from Mr Dow's account of their sacred books, appear to believe invariably in the unity, eternity, omniscience, and omnipotence of God; and the polytheism of which they have been accused is no more than a symbolical worship of the divine attributes, which they divide into three classes. Under the name of *Brimha*, they worship the wisdom and creative power of God; under the appellation of *Bishen*, his providential and preserving quality; and under that of *Shibah*, that attribute which tends to destroy.

As few of our readers may have an opportunity of perusing the Shaster, we shall, by way of specimen, subjoin a passage from it, which, though it contains some metaphysical mysteries concerning the creation, yet discovers views of God so enlightened that they would not disgrace more refined nations. The passage which we shall quote is the first chapter of the Shaster, which is a dialogue between Brimha the Wisdom of the Divinity, and Narud or Reason, who is represented as the son of Brimha. Narud desires to be instructed by his father; and for that purpose puts the following questions to him:

"*Narud.* O father! thou first of God, thou art said to have created the world, and thy son Narud, astonished at what he beholds, is desirous to be instructed how all these things were made.

"*Brimha.* Be not deceived, my son! do not imagine that

Shafter. that I was the creator of the world, independent of the Divine Mover, who is the great original essence and creator of all things. Look, therefore, only upon me as the instrument of the great *will*, and a part of his being, whom he called forth to execute his eternal designs.

" *Narud.* What shall we think of God?

" *Brimha.* Being immaterial, he is above all conception; being invisible, he can have no form; but, from what we behold in his works, we may conclude that he is eternal, omnipotent, knowing all things, and present everywhere.

" *Narud.* How did God create the world?

" *Brimha.* Affection dwelt with God from all eternity. It was of three different kinds; the creative, the preserving, and the destructive. This first is represented by Brimha, the second by Bishen, and the third by Shibah. You, O Narud! are taught to worship all the three in various shapes and likenesses, as the Creator, the Preserver, and the Destroyer. The affection of God then produced power, and power, at a proper conjunction of time and fate, embraced goodness, and produced matter. The three qualities then acting upon matter, produced the universe in the following manner: From the opposite actions of the creative and destructive quality in matter, self-motion first arose. Self-motion was of three kinds; the first inclining to plasticity, the second to discord, and the third to rest. The discordant actions then produced the Akash (a kind of celestial element), which invisible element possessed the quality of conveying sound; it produced air, a palpable element; fire, a visible element; water, a fluid element; and earth, a solid element.

" The Akash dispersed itself abroad. Air formed the atmosphere; fire, collecting itself, blazed forth in the host of heaven; water rose to the surface of the earth, being forced from beneath by the gravity of the latter element. Thus broke forth the world from the veil of darkness, in which it was formerly comprehended by God. Order rose over the universe. The seven heavens were formed, and the seven worlds were fixed in their places; there to remain till the great dissolution, when all things shall be absorbed into God.

" God seeing the earth in full bloom, and that vegetation was strong from its seeds, called forth for the first time intellect, which he endued with various organs and shapes, to form a diversity of animals upon the earth. He endued the animals with five senses; feeling, seeing, smelling, tasting, and hearing; but to man he gave reflection, to raise him above the beasts of the field.

" The creatures were created male and female, that they might propagate their species upon the earth. Every herb bore the seed of its kind, that the world might be clothed with verdure, and all animals provided with food.

" *Narud.* What dost thou mean, O father! by Intellect?

" *Brimha.* It is a portion of the *great soul* of the universe breathed into all creatures, to animate them for a certain time.

" *Narud.* What becomes of it after death?

" *Brimha.* It animates other bodies, or returns, like a drop, into that unbounded ocean from which it first arose.

" *Narud.* Shall not then the souls of good men receive rewards? nor the souls of the bad meet with punishment? Shafter, Shaw.

" *Brimha.* The souls of men are distinguished from those of other animals; for the first are endued with reason, and with a consciousness of right and wrong. If therefore man shall adhere to the first, as far as his powers shall extend, his soul, when disengaged from the body by death, shall be absorbed into the divine essence, and shall never more reanimate flesh: But the souls of those who do evil are not, at death, disengaged from all the elements. They are immediately clothed with a body of fire, air, and akash, in which they are for a time punished in hell. After the season of their grief is over, they reanimate other bodies; but till they shall arrive at a state of purity they can never be absorbed into God.

" *Narud.* What is the nature of that absorbed state which the souls of good men enjoy after death?

" *Brimha.* It is a participation of the divine nature, where all passions are utterly unknown, and where consciousness is lost in bliss.

" *Narud.* Thou sayest, O father, that unless the soul is perfectly pure it cannot be absorbed into God: now, as the actions of the generality of men are partly good and partly bad, whither are their spirits sent immediately after death?

" *Brimha.* They must atone for their crimes in hell, where they must remain for a space proportioned to the degree of their iniquities; then they rise to heaven to be rewarded for a time for their virtues; and from thence they will return to the world to reanimate other bodies.

" *Narud.* What is time?

" *Brimha.* Time existed from all eternity with God: but it can only be estimated since motion was produced, and only be conceived by the mind, from its own constant progress.

" *Narud.* How long shall this world remain?

" *Brimha.* Until the four jugs shall have revolved. Then Rudder (the same with *Shibah*, the destroying quality of God), with the ten spirits of dissolution, shall roll a comet under the moon, that shall involve all things in fire, and reduce the world into ashes. God shall then exist alone, for matter will be totally annihilated."

Those who desire more information on this subject may consult Dow's History of Indostan, and Holwell's Interesting Historical Events.

SHAW, Dr Thomas, known to the learned world by his travels to Barbary and the Levant, was born at Kendal in Westmoreland about the year 1692. He was appointed chaplain to the English consul at Algiers, in which station he continued for several years; and from thence took proper opportunities of travelling into different parts. He returned in 1733; was elected fellow of the Royal Society; and published the account of his travels at Oxford, folio, 1738. In 1740 he was nominated principal of St Edmond-hall, which he raised from a ruinous state by his munificence; and was regius professor of Greek at Oxford until his death, which happened in 1751. Dr Clayton, bishop of Clogher, having attacked these Travels in his Description of the East, Dr Shaw published a supplement by way of vindication,

dication, which is incorporated into the second edition of his Travels, prepared by himself, and published in 4to, 1757.

SHAWIA, a genus of plants, belonging to the class syngenesia, and order polygamia segregata, of which the characters are the following; the calyx is imbricated with five or six leaves, the three interior of which are larger; the corolla is five-cleft; there is one oblong seed. One species only has been discovered, which is a native of New Zealand.

SHAWLS, are woollen handkerchiefs, an ell wide, and near two long. The wool is so fine and silky, that the whole handkerchief may be contained in the two hands closed. It is the produce of a Tibet sheep; but some say that no wool is employed but that of lambs torn from the belly of their mother before the time of birth. The most beautiful shawls come from Cashmire: their price is from 150 livres (about six guineas) to 1200 livres (or 50l. sterling).

In the Transactions of the Society for Encouraging Arts, Manufactures, &c. for the year 1792, we are informed that a shawl counterpane, four yards square, manufactured by Mr P. J. Knights of Norwich, was presented to the society; and that, upon examination, it appeared to be of greater breadth than any goods of equal fineness and texture that had ever before been presented to the society, or to their knowledge woven in this country. The shawls of Mr Knights's manufacture, it is said, can scarcely be distinguished from Indian shawls, though they can be afforded at one-twentieth part of the price. When the shawl is 16 quarters square, Mr Knights says it may be retailed at 20l.; if it consisted of 12 quarters, and embroidered as the former, it will cost 15l.; if plain, with a fringe only, a shawl of 16 quarters square may be sold at 8l. 8s.; if 12 quarters and fringed, at 6l. 6s.

Mr Knights maintains, that his counterpane of four yards square is equal in beauty, and superior in strength, to the Indian counterpanes, which are sold at 200 guineas. The principal consumption of this cloth is in train-dresses for ladies; as likewise for long scarfs, in imitation of the real Indian scarfs, which are sold from 60l. to 80l.; whereas scarfs of this fabric are sold for as many shillings, and the ladies square shawls in proportion.

SHEADING, a riding, tything, or division, in the isle of Man; the whole island being divided into six sheadings; in every one of which is a coroner or chief constable, appointed by the delivery of a rod at the annual convention.

SHEARBILL, the *Rhynchops Nigra* of Linnæus, the *Black Skimmer* of Pennant and Latham, and *Cutwater* of Catesby. See ORNITHOLOGY *Index*.

SHEATHING, in the sea-language, is the casing that part of a ship which is to be under water with firboard of an inch thick; first laying hair and tar mixed together under the boards, and then nailing them on, in order to prevent worms from eating the ship's bottom.—Ships of war are now generally sheathed with copper: but copper sheathing is liable to be corroded by the action of salt water, and something is still wanting to effect this purpose. It is very probable that tar might answer very well.

In the Cornish mines, copper or brass pumps are often placed in the deepest parts, and are consequently exposed to the vitriolic or other mineral waters with which some of these mines abound, and which are known to have a much stronger effect on copper than sea water. These pumps are generally about six feet long, and are screwed together, and made tight by the interposition of a ring of lead, and the joinings are afterwards tarred. One of these pumps was so much corroded as to render it unfit for use; but the spots of tar, which by accident had dropped on it, preserved the parts they covered from the action of the water. These projected in some places more than a quarter of an inch; and the joints were so far defended by the thin coat of tar, that it was as perfect as when it came from the hands of the manufacturer. If tar thus effectually defends copper from these acrid waters, can there remain a doubt of its preserving it from the much milder waters of the sea?

SHEATS, in a ship, are ropes bent to the clews of the sails, serving in the lower sails to haul aft the clews of the sail; but in topsails they serve to haul home the clew of the sail close to the yard-arm.

SHEAVE, in *Mechanics*, a solid cylindrical wheel, fixed in a channel, and moveable about an axis, as being used to raise or increase the mechanical powers applied to remove any body.

SHEBBEARE, JOHN, a political writer, was born at Bideford in Devonshire, in the year 1709. He received the rudiments of his education at the free grammar school of Exeter. It has been often observed, that the future life of a man may be gathered from his puerile character; and accordingly Shebbeare, while a boy at school, gave the strongest indications of his future eminence in misanthropy and learning, by the extraordinary tenaciousness of his memory and the readiness of his wit, as well as the malignity of his disposition; being universally regarded as a young man of surprising genius, while at the same time he was despised for his malicious temper.

About the age of 16, Shebbeare was bound apprentice to an eminent surgeon in his native town, under whom he acquired a considerable share of medical knowledge. His talent for lampoon appeared at this early period, and he could not forbear from exercising it on his master; but the chief marks for the arrows of his wit were the gentlemen of the corporation, some of whom laughed at such trifles, while such as were irritable often commenced prosecutions against him, but without success. He was frequently summoned to appear at the sessions, for daring to speak and write disrespectfully of the magistrates; but the laugh was always on the side of Shebbeare.

When his time was out, he set up for himself, then discovering a taste for chemistry; soon after which he married an amiable young woman with no fortune, but of respectable connections. Failing in business at Bideford, he went to Bristol in 1736, entering into partnership with a chemist, and never afterwards visited his native town.

The attention of the public was, in the year 1739, attracted by an epitaph to the memory of Thomas Coster, Esq. M. P. for Bristol, in which he contrived to raise emotions of pity, grief, and indignation. In the following year he published a pamphlet on the Bristol waters, after which we know little or nothing respecting him for a number of years. He was at Paris in 1752, where he obtained, it is said, the degree of doctor in medicine,

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Shebbeare.

a fact, however, which many are difpofed to queftion. About this time he began to emerge from obfcurity, and draw the attention of the public, by pamphlets written with fuch virulence and celerity as it would be difficult to equal in the moft intemperate times. In 1754 he commenced his career with a work denominated the *Marriage Act*, a political novel, in which he treated the legiflature with fuch freedom that he was apprehended, but foon after fet at liberty.

The moft celebrated performances, however, were a feries of letters to the People of England, written in a vigorous and energetic ftyle, well calculated to make an impreffion on common readers; and they were of courfe read with avidity, and diligently circulated. They galled the miniftry, who at firft were too eager to punifh the author. When the third letter was publifhed, warrants were iffued by Lord Holderneffe in March 1756, to take up both the publifher and the author; a profecution which appears to have been dropt. On the 12th of January 1758, the fame nobleman figned a general warrant for apprehending the author, printer, and publifhers of a wicked, audacious, and treafonable libel, entitled, "A fixth letter to the people of England, on the progrefs of national ruin, in which is fhewn that the prefent grandeur of France and calamities of this nation are owing to the influence of Hanover on the councils of England;" and then having found, to feize and apprehend, together with their books and papers.

Government having received information that a feventh letter was in the prefs, all the copies were feized and fuppreffed by virtue of another warrant, dated January 23. In Eafter term an information was filed againft him by the attorney-general, and on the 17th of June the information was tried, when Shebbeare was found guilty; and on the 28th of November he received fentence, by which he was fined 5l. ordered to ftand in the pillory December 5. at Charing Crofs, to be confined three years, and to give fecurity for his good behaviour for feven years, himfelf in 500l. and two others in 250l. each. During his confinement, he declared he never received as prefents more than 20 guineas from all the world.

He was detained in prifon during the whole time of the fentence, and with fome degree of rigour; for when his life was in danger from a bad ftate of health, and he applied to the court of king's-bench for permiffion to be carried into the rules a few hours in a day; though Lord Mansfield acceded to the petition, the prayer of it was denied and defeated by Judge Fofter. At the termination of the time of his fentence, a new reign commenced; and fhortly afterwards, during Mr Grenville's adminiftration, a penfion of 200l. a-year was granted him by the crown, through the influence of Sir John Philips; and he ever after became devoted to the fervice of government. He was of courfe abufed in almoft every periodical work, which he feems in general to have had the good fenfe to neglect. Dr Smollet introduced him, in no very refpectful light, under the name of Ferret, in Sir Launcelot Greaves; and Mr Hogarth made him one of the group in the third election print.

During the latter part of his life he feems to have written but little. He ftrenuoufly fupported the miniftry during the American war, having publifhed, in 1775, an anfwer to the printed fpeech of Edmund Burke, Efq. fpoken in the houfe of commons, April 19. 1774, wherein he inveftigates his knowledge of polity, legiflature, human kind, hiftory, commerce, and finance; his arguments are examined; the conduct of adminiftration is boldly defended, and his talents as an orator clearly expofed to view. An effay on the origin, progrefs, and eftablifhment of National Society; in which the principles of government, the definition of phyfical, moral, civil, and religious liberty contained in Dr Price's obfervations, &c. are examined and controverted; together with a juftification of the legiflature in reducing America to obedience by force.

Shebbeare, Sheep.

His publications of a fatirical, political, and medical nature, amount to 34, befides a novel called Filial Piety, in which hypocrify and bluftering courage are very properly chaftifed. He died on the 1ft of Auguft 1788, leaving behind him the character of a benevolent man among thofe who were beft acquainted with him; a character which, from the manner he fpeaks of his connections, he probably deferved.

SHEEP, in *Zoology*. See OVIS and WOOL. 1

Sheep ferve a wonderfull variety of purpofes.

Amongft the various animals with which Divine Providence has ftored the world for the ufe of man, none is to be found more innocent, more ufeful, or more valuable, than the fheep. The fheep fupplies us with food and clothing, and finds ample employment for our poor at all times and feafons of the year, whereby a variety of manufactures of woollen cloth is carried on without interruption to domeftic comfort and lofs to friendly fociety or injury to health, as is the cafe with many other occupations. Every lock of wool that grows on its back becomes the means of fupport to ftaplers, dyers, pickers, fcourers, fcriblers, carders, combers, fpinners, fpoolers, warpers, queelers, weavers, fullers, tuckers, burlers, fhearmen, preffers, clothiers, and packers, who, one after another, tumble and tofs, and twift, and bake, and boil, this raw material, till they have each extracted a livelihood out of it; and then comes the merchant, who, in his turn, fhips it (in its higheft ftate of improvement) to all quarters of the globe, from whence he brings back every kind of riches to his country, in return for this valuable commodity which the fheep affords.

Befides this, the ufeful animal, after being deprived of his coat, produces another againft the next year; and when we are hungry, and kill him for food, he gives us his fkin to employ the fell-mongers and parchment-makers, who fupply us with a durable material for fecuring our eftates, rights, and poffeffions; and if our enemies take the field againft us, fupplies us with a powerful inftrument for roufing our courage to repel their attacks. When the parchment-maker has taken as much of the fkin as he can ufe, the glue-maker comes after and picks up every morfel that is left, and therewith fupplies a material for the carpenter and cabinet-maker, which they cannot do without, and which is effentially neceffary before we can have elegant furniture in our houfes; tables, chairs, looking-glaffes, and a hundred other articles of convenience: and when the winter nights come on, while we are deprived of the cheering light of the fun, the fheep fupplies us with an artificial mode of light, whereby we preferve every pleafure of domeftic fociety, and with whofe affiftance we can continue our work, or write or read, and improve

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Sheep. our minds, or enjoy the social mirth of our tables. Another part of the slaughtered animal supplies us with an ingredient necessary for making good common soap, a useful store for producing cleanliness in every family, rich or poor. Neither need the horns be thrown away; for they are converted by the button-makers and turners into a cheap kind of buttons, tips for bows, and many useful ornaments. From the very trotters an oil is extracted useful for many purposes, and they afford good food when baked in an oven.

Even the bones are useful also; for by a late invention of Dr Higgins, they are found, when reduced to ashes, to be an useful and essential ingredient in the composition of the finest artificial stone in ornamental work for chimney-pieces, cornices of rooms, houses, &c. which renders the composition more durable by effectually preventing its cracking (A).

If it is objected to the meek inoffensive creature, that he is expensive while living, in eating up our grass, &c. it may be answered that it is quite the contrary; for he can feed where every other animal has been before him and grazed all they could find; and that if he takes a little grass on our downs or in our fields, he amply repays us for every blade of grass in the richness of the manure which he leaves behind him. He protects the hands from the cold wintry blast, by providing them with the softest leather gloves. Every gentleman's library is also indebted to him for the neat binding of his books, for the sheath of his sword, and for cases for his instruments; in short, not to be tedious in mentioning the various uses of leather, there is hardly any furniture or utensil of life but the sheep contributes to render either more useful, convenient, or ornamental.

As the sheep is so valuable an animal, every piece of information concerning the proper method of managing it must be of importance. It will not therefore be useless or unentertaining to give some account of the manner of managing sheep in Spain, a country famous for producing the best wool in the world.

Account of the Spanish sheep

In Spain there are two kinds of sheep: the coarse-woolled sheep, which always remain in their native country, and are housed every night in winter; and the fine-woolled sheep, which are always in the open air, and travel every summer from the cool mountains of the northern parts of Spain, to feed in winter on the southern warm plains of Andalusia, Mancha, and Estremadura. Of these latter, it appears from accurate computations, that there are about five millions (B); and that the wool and flesh of a flock of 10,000 sheep produced yearly about 24 reals a-head, about the value of 12 English sixpences, one of which belongs to the owner, three to the king, and the other eight are allowed for the expences of pasture, tythes, shepherds, dogs, salt, shearing, &c. Ten thousand sheep form a flock, which is divided into ten tribes, under the management of one person, who has absolute dominion over fifty shepherds and fifty dogs.

3 Of Segovia,

M. Bourgoanne, a French gentleman, who resided many years in Spain, and directed his inquiries chiefly to the civil government, trade, and manufactures, of that country, gives the following account of the wandering sheep of Segovia. "It is (says he) in the neighbouring mountains that a part of the wandering sheep feed during the fine season. They leave them in the month of October, pass over those which separate the two Castiles, cross New Castile, and disperse themselves in the plains of Estramadura and Andalusia. For some years past those of the two Castiles, which are within reach of the Sierra-Morena, go thither to pass the winter; which, in that part of Spain, is more mild; the length of their day's journey is in proportion to the pasture they meet with. They travel in flocks from 1000 to 1200 in number, under the conduct of two shepherds; one of whom is called the *Mayoral*, the other the *Zagal*. When arrived at the place of their destination, they are distributed in the pastures previously assigned them. They return in the month of April; and whether it be habit or natural instinct that draws them towards the climate, which at this season becomes most proper for them, the inquietude which they manifest might, in case of need, serve as an almanac to their conductors."

Bourgoanne's Travels, vol. i. p. 53.

Mr Arthur Young, in that patriotic work which he conducted with great industry and judgement, the Annals of Agriculture, gives us a very accurate and interesting account of the Pyrenean or Catalonian sheep.

4 Of Catalonia. *Annals of Agriculture*, vol. vii. p. 195.

"On the northern ridge, bearing to the west, are the pastures of the Spanish flocks. This ridge is not, however, the whole; there are two other mountains, quite in a different situation, and the sheep travel from one to another as the pasturage is short or plentiful. I examined the soil of these mountain pastures, and found it in general stony; what in the west of England would be

(A) Any curious person would be much entertained to see the manufactory of bone-ash, now (about 1794) carried on by Mr Minish of White-chapel, New Road, wherein the bones of sheep and cows undergo many ingenious processes. 1. There is a mill to break them; 2. A cauldron to extract their oil, marrow, and fat; 3. A reverberatory to heat them red hot; 4. An oven for those bones to moulder to ashes; 5. A still to collect the fumes of the burnt bones into a brown fluid, from whence hartshorn is made; 6. Furnaces for making parts thereof into Glauber's salts; 7. A sand heat containing twelve jars, for collecting a crystallizing vapour into sal-ammoniac.

(B) In the 16th century the travelling sheep were estimated at seven millions: under Phillip III. the number was diminished to two millions and a half. Ustariz, who wrote at the beginning of the 18th century, made it amount to four millions. The general opinion is, that at present it does not exceed five millions. If to this number the eight millions of stationary sheep be added, it will make nearly thirteen millions of animals, all managed contrary to the true interests of Spain, for the advantage of a few individuals. For the proprietors of stationary flocks also have privileges which greatly resemble those of the members of the Mesta. According to Arriquebar, Spain contains eight millions of fine-woolled sheep, ten millions of coarse-woolled, and five hundred thousand bulls, oxen, and cows.

Sheep.

be called a *ſi ne braſh*, with ſome mixture of loam, and in a few places a little peaty. The plants are many of them untouched by the ſheep; many ferns, narciſſus, violets, &c. but burnet (*poterium ſanguiſorba*) and the narrow-leaved plantain (*plantago lanceolata*) were eaten, as may be ſuppoſed, cloſe. I looked for trefoils, but found ſcarcely any: it was very apparent that ſoil and peculiarity of herbage had little to do in rendering theſe heights proper for ſheep. In the northern parts of Europe, the tops of mountains half the height of theſe (for we were above ſnow in July) are bogs, all are ſo which I have ſeen in our iſlands, or at leaſt the proportion of dry land is very trifling to that which is extremely wet: Here they are in general very dry. Now a great range of dry land, let the plants be what they may, will in every country ſuit ſheep. The flock is brought every night to one ſpot, which is ſituated at the end of the valley on the river I have mentioned, and near the port or paſſage of Picada: it is a level ſpot ſheltered from all winds. The ſoil is eight or nine inches deep of old dung, not at all incloſed: from the freedom from wood all around, it ſeems to be choſen partly for ſafety againſt wolves and bears. Near it is a very large ſtone, or rather rock, fallen from the mountain. This the ſhepherds have taken for a ſhelter, and have built a hut againſt it; their beds are ſheep ſkins, and their door ſo ſmall that they crawl in. I ſaw no place for fire; but they have it, ſince they dreſs here the fleſh of their ſheep, and in the night ſometimes keep off the bears, by whirling fire-brands: four of them belonging to the flock mentioned above lie here. I viewed their flock very carefully, and by means of our guide and interpreter, made ſome inquiries of the ſhepherds, which they anſwered readily, and very civilly. A Spaniard at Venaſque, a city in the Pyrenees, gives 600 livres French (the livre is $10\frac{1}{2}$d. Engliſh) a-year for the paſturage of this flock of 2000 ſheep. In the winter he ſends them into the lower parts of Catalonia, a journey of 12 or 13 days, and when the ſnow is melted in the ſpring, they are conducted back again. They are the whole year kept in motion, and moving from ſpot to ſpot, which is owing to the great range they everywhere have of paſture. They are always in the open air, never houſed or under cover, and never taſte of any food but what they can find on the hills.

"Four ſhepherds, and from four to ſix large Spaniſh dogs, have the care of this flock: the latter are in France called of the *Pyrenees breed;* they are black and white, of the ſize of a large wolf, a large head and neck, armed with collars ſtuck with iron ſpikes. No wolf can ſtand againſt them; but bears are more potent adverſaries: if a bear can reach a tree, he is ſafe; he riſes on his hind legs, with his back to the tree, and ſets the dogs at defiance. In the night the ſhepherds rely entirely on their dogs; but on hearing them bark are ready with fire-arms, as the dogs rarely bark if a bear is not at hand. I was ſurpriſed to find that they are fed only with bread and milk. The head ſhepherd is paid 120 livres a-year wages and bread; the others [illegible] livres and bread. But they are allowed to keep goats, of which they have many, which they milk every day. Their food is milk and bread, except the fleſh of ſuch ſheep or [illegible] as accidents give them. The head ſhepherd keeps on the mountain top, or an elevated ſpot, from [illegible] he can the better ſee around while the flock traverſes the declivities. In doing this the ſheep are expoſed to great danger in places that are ſtony; for by walking among the rocks, and eſpecially the goats, they move the ſtones, which, rolling down the hills, acquire an accelerated force enough to knock a man down, and ſheep are often killed by them; yet we ſaw how alert they were to avoid ſuch ſtones, and cautiouſly on their guard againſt them. I examined the ſheep attentively. They are in general polled, but ſome have horns; which in the rams turn backwards behind the ears and project half a circle forward; the ewes horns turn alſo behind the ears, but do not project: the legs white or reddiſh; ſpeckled faces, ſome white, ſome reddiſh; they would weigh fat, I reckon, on an average, from 15 lb. to 18 lb. a quarter. Some tails ſhort, ſome left long. A few black ſheep among them: ſome with a very little tuft of wool on their foreheads. On the whole they reſemble thoſe on the South Downs; their legs are as ſhort as thoſe of that breed; a point which merits obſervation, as they travel ſo much and ſo well. Their ſhape is very good, round ribs and flat ſtraight backs; and would with us be reckoned handſome ſheep; all in good order and fleſh. In order to be ſtill better acquainted with them, I deſired one of the ſhepherds to catch a ram for me to feel, and examine the wool, which I found very thick and good of the carding ſort, as may be ſuppoſed. I took a ſpecimen of it, and alſo of a hoggit, or lamb of laſt year. In regard to the mellow ſoftneſs under the ſkin, which, in Mr Bakewell's opinion, is a ſtrong indication of a good breed, with a diſpoſition to fatten, he had it in a much ſuperior degree to many of our Engliſh breeds, to the full as much ſo as the South Downs, which are for that point the beſt ſhort-woolled ſheep which I know in England. The fleece was on his back, and weighed, as I gueſſed, about 8 lb. Engliſh; but the average, they ſay, of the flock is from four to five, as I calculated by reducing the Catalonian pound of 12 oz. to ours of 16, and is all ſold to the French at 30s. the lb. French. This ram had the wool of the back part of his neck tied cloſe, and the upper tuft tied a ſecond knot by way of ornament; nor do they ever ſhear this part of the fleece for that reaſon we ſaw ſeveral in the flock with this ſpecies of decoration. They ſaid that this ram would ſell in Catalonia for 20 livres. A circumſtance which cannot be too much commended, and deſerves univerſal imitation, is the extreme docility they accuſtom them to. When I deſired the ſhepherd to catch one of his rams, I ſuppoſed he would do it with his crook, or probably not be able to do it at all; but he walked into the flock, and ſingling out a ram and a goat, bid them follow him, which they did immediately; and he talked to them while they were obeying him, holding out his hand as if to give them ſomething. By this method he brought me the ram, which I caught, and held without difficulty."

The beſt ſort of ſheep for fine wool are thoſe bred in Herefordſhire, Devonſhire, and Worceſterſhire; but they are ſmall, and black faced, and bear but a ſmall quantity. Warwick, Leiceſterſhire, Buckingham, and Northamptonſhire, breed a large-boned ſheep, of the beſt ſhape and deepeſt wool we have. The marſhes of Lincolnſhire breed a very large kind of ſheep, but their wool is not good, unleſs the breed [illegible] by bringing in ſheep of other counties among them, which [illegible] of late [illegible] allowed them. It [illegible]

What ſheep [illegible] the beſt wool.

Sheep. this county, it is no uncommon thing to give fifty guineas for a ram, and a guinea for the admiffion of an ewe to one of thefe valuable males, or twenty guineas for the ufe of it for a certain number of ewes during one feafon. Suffolk alfo breeds a very valuable kind of fheep. The northern counties in general breed fheep with long but hairy wool: however, the wool which is taken from the neck and fhoulders of the Yorkfhire fheep is ufed for mixing with Spanifh wool in fome of their fineft cloths.

Wales bears a fmall hardy kind of fheep, which has the beft tafted flefh, but the worft wool of all. Neverthelefs it is of more extenfive ufe than the fineft Segovian fleeces; for the benefit of the flannel manufacture is univerfally known. The fheep of Ireland vary like thofe of Great Britain; thofe of the fouth and eaft being large and their flefh rank: thofe of the north and the mountainous parts fmall and their flefh fweet. The fleeces in the fame manner differ in degrees of value. Scotland breeds a fmall kind, and their fleeces are coarfe.

But the new Leicefterfhire breed is the moft fafhionable, and of courfe the moft profitable breed in the ifland. Jofeph Altom of Clifton, who raifed himfelf from a plough-boy, was the firft who diftinguifhed himfelf in the midland counties of England for a fuperior breed of fheep. How he improved his breed is not known; but it was cuftomary for eminent farmers in his time to go to Clifton in fummer to choofe and purchafe ram-lambs, for which they paid two or three guineas. This man was fucceeded by Mr Bakewell; and it may reafonably be fuppofed that the breed, by means of Altom's ftock, had paffed the firft ftage of improvement before Mr Bakewell's time. Still, however, it muft be acknowledged, that the Leicefterfhire breed of fheep owes its prefent high ftate of improvement to the ability and care of Mr Bakewell.

6 Account of Mr Bakewell's breed. *Marfhall's Midland Counties*, vol. i. p. 382.

"The manner in which Mr Bakewell raifed his fheep to the degree of celebrity in which they defervedly ftand, is, notwithftanding the recentnefs of the improvement, and its being done in the day of thoufands now living, a thing in difpute; even among men high in the profeffion, and living in the very diftrict in which the improvement has been carried on!

7 How it is fuppofed he improved it.

"Some are of opinion that he effected it by a crofs with the Wiltfhire breed; an improbable idea, as their form altogether contradicts it: others, that the Ryeland breed were ufed for this purpofe; and with fome fhow of probability. If any crofs whatever was ufed the Ryeland breed, whether we view the form, the fize, the wool, the flefh, or the fatting quality, is the moft probable inftrument of improvement.

"Thefe ideas, however, are regiftered merely as matters of opinion. It is more than probable that Mr Bakewell alone is in poffeffion of the feveral minutiæ of improvement; and the public can only hope that at a proper time the facts may be communicated for the direction of future improvers.

"Whenever this fhall take place, it will moft probably come out that no crofs with any alien breed whatever has been ufed; but that the improvement has been effected by felecting individuals from kindred breeds; from the feveral breeds or varieties of long-woolled fheep, with which Mr Bakewell was furrounded on almoft every fide, and by breeding, *inandin* (c), with this felection: folicitoufly feizing the fuperior accidental varieties produced; affociating thefe varieties; and ftill continuing to felect, with judgement, the fuperior individuals.

8 Defcription of his ewes and wedders.

"It now remains to give a defcription of the fuperior clafs of individuals of this breed, efpecially ewes and wedders, in full condition, but not immoderately fat. The rams will require to be diftinguifhed afterwards.

"The head is long, fmall, and hornlefs, with ears fomewhat long, and ftanding backward, and with the nofe fhooting forward. The neck thin, and clean toward the head; but taking a conical form; ftanding low, and enlarging every way at the bafe; the fore-end altogether fhort. The bofom broad, with the fhoulders, ribs, and chine extraordinary full. The loin broad, and the back level. The haunches comparatively full toward the hips, but light downward; being altogether fmall in proportion to the fore-parts. The legs, at prefent, of a moderate length; with the bone extremely fine. The bone throughout remarkably light. The carcafe, when fully fat, takes a remarkable form; much wider than it is deep, and almoft as broad as it is long. Full on the fhoulder, wideft on the ribs, narrowing with a regular curve towards the tail; approaching the form of the turtle nearer perhaps than any other animal. The pelt is thin, and the tail fmall. The wool is fhorter than long wools in general, but much longer than the middle wools; the ordinary length of ftaple five to feven inches, varying much in finenefs and weight."

9 Fatten remarkably well.

This breed furpaffes every other in beauty of form; they are full and weighty in the fore quarters; and are remarkable for fmallnefs of bone. Mr Marfhall, who has been of fo much benefit to agriculture and his country by his publications, informs us, in his Rural Economy of the Midland Counties, that he has feen a rib of a fheep of this breed contrafted with one of a Norfolk fheep: the difparity was ftriking; the latter nearly twice the fize; while the meat which covered the former was three times the thicknefs: confequently the proportion of meat to bone was in the one incomparably greater than in the other. Therefore, in this point of view, the improved breed has a decided preference: for furely while mankind continue to eat flefh and throw away bone, the former muft be, to the confumer at leaft, the more valuable.

The criterions of good and bad flefh while the animal is alive differ in different fpecies, and are not properly fettled in the fame fpecies. One fuperior breeder is of opinion, that if the flefh is not loofe, it is of courfe good; holding, that the flefh of fheep is never found in a ftate of hardnefs, like that of ill-flefhed cattle: while others make a fourfold diftinction of the flefh of fheep; as loofenefs, mellownefs, firmnefs, hardnefs: confidering the firft and the laft equally exceptionable, and the fecond and third equally defirable; a happy mixture of the two being deemed the point of perfection.

The

(c) *Inandin* is a term ufed in the midland counties of England to exprefs breeding from the fame family.

SHIP.

Plate CCCCLXX.

A FIRST RATE SHIP of WAR with Rigging &c. at Anchor.

Fig. 1.

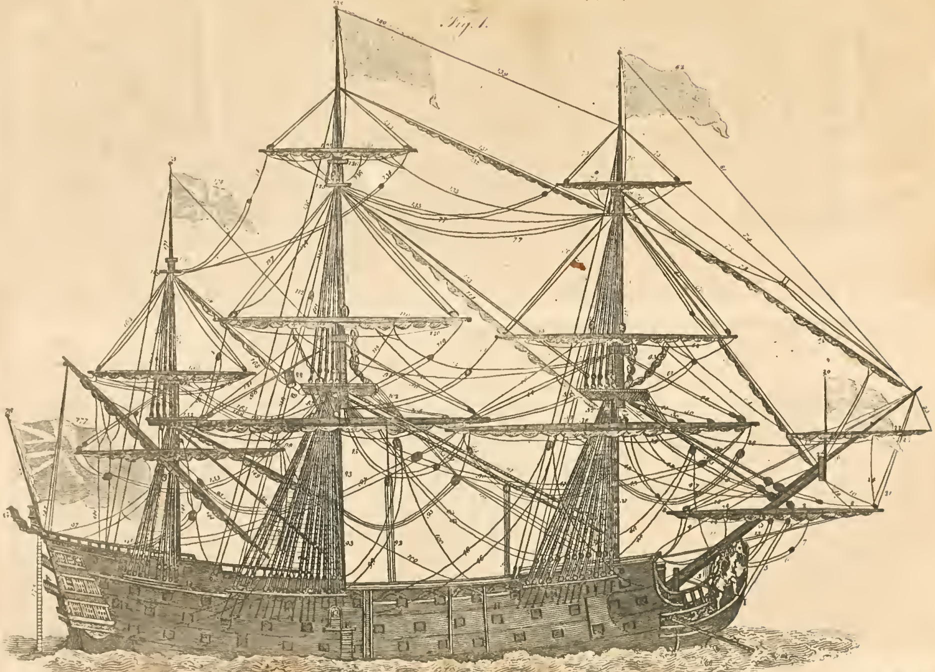


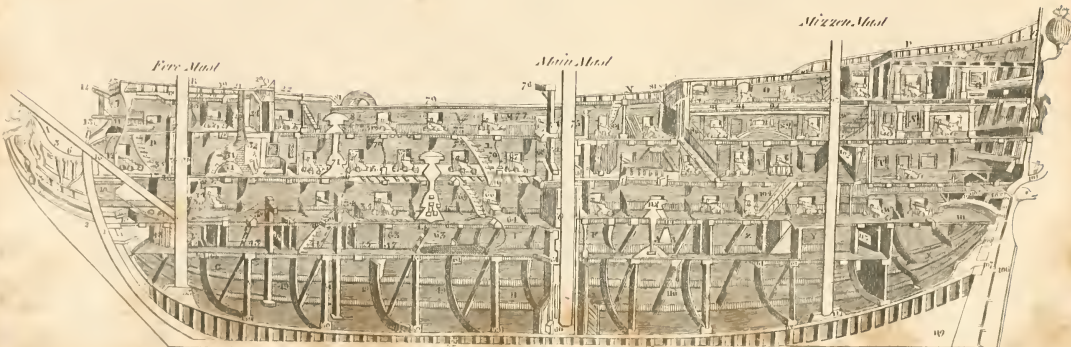
Fig. 3.

Fig. 4.

Fig. 5.

Fig. 2.

The Section of a First Rate Ship of War, Shewing its various Timbers and Apartments.

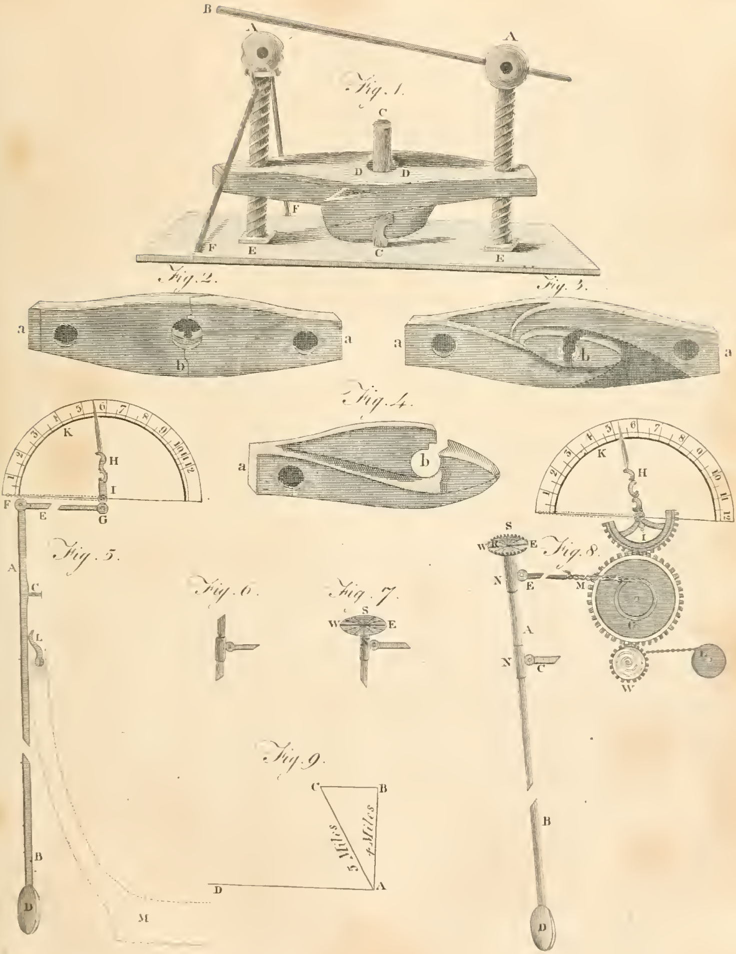


SHIP.

Plate CCCCLXXXII

Machine for drawing

SHIP BOLTS.



E. Mitchell fecit

Sheep.

The flesh of sheep, when slaughtered, is well known to be of various qualities. Some is composed of large coarse grains, interspersed with wide empty pores like a sponge: others, of large grains, with wide pores filled with fat; others, of fine close grains, with smaller pores filled with fat: and a fourth, of close grains, without any intermixture of fatness.

The flesh of sheep, when dressed, is equally well known to possess a variety of qualities: some mutton is coarse, dry, and insipid; a dry sponge, affording little or no gravy of any colour. Another sort is somewhat firmer, imparting a light-coloured gravy only. A third plump, short, and palatable; affording a mixture of white and red gravy. A fourth likewise plump and well-flavoured, but discharging red gravy, and this in various quantities.

It is likewise observable, that some mutton, when dressed, appears covered with a thick, tough, parchment-like integument; others with a membrane comparatively fine and flexible. But these, and some of the other qualities of mutton, may not be wholly owing to breed, but in part to the age and the state of fatness at the time of slaughter. Examined in this light, whether we consider the degree of fatness, or their natural propensity to a state of fatness, even at an early age, the improved breed of Leicestershire sheep appears with many superior advantages.

The degree of fatness to which the individuals of this breed are capable of being raised, will perhaps appear incredible to those who have not had an opportunity of being convinced by their own observation. "I have seen wedders (says Mr Marshall) of only two shear (two or three years old) so loaded with fat as to be scarcely able to make a run; and whose fat lay so much without the bone, it seemed ready to be shaken from the ribs on the smallest agitation.

Midland Counties, vol. i. p. 398.

"It is common for the sheep of this breed to have such a projection of fat upon the ribs, immediately behind the shoulder, that it may be easily gathered up in the hand, as the flank of a fat bullock. Hence it has gained, in technical language, the name of the *fore-flank*; a point which a modern breeder never fails to touch in judging of the quality of this breed of sheep.

"What is, perhaps, still more extraordinary, it is not rare for the rams, at least of this breed, to be 'cracked on the back;' that is, to be cloven along the top of the chine, in the manner fat sheep generally are upon the rump. This mark is considered as an evidence of the best blood.

"Extraordinary, however, as are these appearances while the animals are living, the facts are still more striking after they are slaughtered. At Litchfield, in February 1785, I saw a fore quarter of mutton, fatted by Mr Princep of Croxall, and which measured upon the ribs four inches of fat. It must be acknowledged, however, that the Leicestershire breed do not produce so much wool as most other long-woolled sheep."

As the practice of letting rams by the season is now become profitable, it may be useful to mention the method of rearing them.

10 How the rams are reared.

"The principal ram-breeders save annually twenty, thirty, or perhaps forty ram lambs; castration being seldom applied, in the first instance, to the produce of a valuable ram, for in the choice of these lambs they are led more by blood or parentage, than by form; on which, at an early age, little dependence can be placed. Their treatment from the time they are weaned, in July or August, until the time of shearing, the first week in June, consists in giving them every indulgence of keep, in order to push them forward for the show; it being the common practice to let such as are fit to be let the first season, while they are yet yearlings—provincially 'sharhogs.'

"Their first pasture, after weaning, is pretty generally, I believe, clover that has been mown early, and has got a second time into head; the heads of clover being considered as a most forcing food of sheep. After this goes off, turnips, cabbages, colewort, with hay, and (report says) with corn. But the use of this the breeders severally deny, though collectively they may be liable to the charge.

"Be this as it may, something considerable depends on the *art of making up*, not lambs only, but rams of all ages. Fat, like charity, covers a multitude of faults; and besides, is the best evidence of their fatting quality which their owners can produce (*i. e.* their natural propensity to a state of fatness), while in the fatness of the sharhogs is seen their degree of inclination to fat at an early age.

"Fatting quality being the one thing needful in grazing stock, and being found, in some considerable degree at least, to be hereditary, the fattest rams are of course the best; though other attachments, well or ill placed, as to form or fashionable points, will perhaps have equal or greater weight in the minds of some men, even in this enlightened age. Such shearlings as will not make up sufficiently as to form and fatness, are either kept on to another year to give them a fair chance, or are castrated, or butchered while sharhogs."

11 What sums Mr Bakewell received for letting them.

From the first letting, about 40 years ago, to the year 1780, the prices kept gradually rising from fifteen shillings to a guinea, and from one to ten. In 1780 Mr Bakewell let several at ten guineas each; and, what is rather inexplicable, Mr Parkinson of Quarndon let one the same year for twenty-five guineas; a price which then astonished the whole country.

From that time to 1786 Mr Bakewell's stock rose rapidly from ten to a hundred guineas; and that year he let two thirds of one ram (reserving one third of the usual number of ewes to himself) to two principal breeders, for a hundred guineas each, the entire services of the ram being rated at three hundred guineas! Mr Bakewell making that year, by letting twenty rams only, more than a thousand pounds!

Since that time the prices have been still rising. Four hundred guineas have been repeatedly given. Mr Bakewell, this year (1789) makes, says Mr Marshall, twelve hundred guineas by three rams (brothers, we believe); two thousand of seven; and of his whole letting, full three thousand guineas!

Beside this extraordinary sum made by Mr Bakewell, there are six or seven other breeders who make from five hundred to a thousand guineas each. The whole amount of moneys produced that year in the midland counties, by letting rams of the modern breed for one season only, is estimated, by those who are adequate to the subject, at the almost incredible sum of ten thousand pounds.

Rams previous to the season are reduced from the cumbrous fat state in which they are shown. The usual time

Sheep.

time of fending them out is the middle of September. They are conveyed in carriages of two wheels with fprings, or hung in flings, 20 or 30 miles a-day, fometimes to the diftance of 200 or 300 miles. They are not turned loofe among the ewes, but kept apart in a fmall inclofure, where a couple of ewes only are admitted at once. When the feafon is over, every care is taken to make the rams look as fat and handfome as poffible.

12
The treatment of the rams and choice of the ewes.

In the choice of ewes the breeder is led by the fame criterions as in the choice of rams. Breed is the firft object of confideration. Excellency, in any fpecies or variety of live-ftock, cannot be attained with any degree of certainty, let the male be ever fo excellent, unlefs the females employed likewife inherit a large proportion of the genuine blood, be the fpecies or variety what it may. Hence no prudent man ventures to give the higher prices for the Difhley rams, unlefs his ewes are deeply tinctured with the Difhley blood. Next to breed is flefh, fat, form, and wool.

After the lambs are weaned, the ewes are kept in common feeding places, without any alteration of pafture, previous to their taking the ram. In winter they are kept on grafs, hay, turnips, and cabbages. As the heads of the modern breed are much finer than moft others, the ewes lamb with lefs difficulty.

The female lambs, on being weaned, are put to good keep, but have not fuch high indulgence fhown them as the males, the prevailing practice being to keep them from the ram the firft autumn.

At weaning time, or previoufly to the admiffion of the ram, the ewes are culled, to make room for the thaves or fhearlings, whofe fuperior blood and fafhion intitle them to a place in the breeding flock. In the work of culling, the ram-breeder and the mere grazier go by fomewhat different guides. The grazier's guide is principally age, feldom giving his ewes the ram after they are four fhear. The ram-breeder, on the contrary, goes chiefly by merit; an ewe that has brought him a good ram or two is continued in the flock fo long as fhe will breed. There are inftances of ewes having been prolific to the tenth or twelfth year; but in general the ewes of this breed go off at fix or feven fhear.

In the practice of fome of the principal ram-breeders, the culling ewes are never fuffered to go out of their hands until after they are flaughtered, the breeders not only fatting them, but having them butchered, on their premifes. There are others, however, who fell them; and fometimes at extraordinary prices. Three, four, and even fo high as ten guineas each, have been given for thefe outcafts.

There are in the flocks of feveral breeders ewes that would fetch at auction twenty guineas each. Mr Bakewell is in poffeffion of ewes which, if they were now put up to be fold to the beft bidder, would, it is eftimated, fetch no lefs than fifty each, and perhaps, through the prefent fpirit of contention, much higher prices.

13
Inftructions for purchafing fheep.

The following inftructions for purchafing fheep, we hope, will be acceptable to our country readers.—The farmer fhould always buy his fheep from a worfe land than his own, and they fhould be big-boned, and have a long greafy wool, curling clofe and well. Thefe fheep always breed the fineft wool, and are alfo the moft approved of by the butcher for fale in the market. For the choice of fheep to breed, the ram muft be young, and his fkin of the fame colour with his wool, for the lambs will be of the fame colour with his fkin. He fhould have a large long body; a broad forehead, round, and well-rifing; large eyes; and ftraight and fhort noftrils. The polled fheep, that is, thofe which have no horns, are found to be the beft breeders. The ewe fhould have a broad back; a large bending neck; fmall, but fhort, clean, and nimble legs; and a thick, deep wool covering her all over.

To know whether they be found or not, the farmer fhould examine the wool that none of it be wanting, and fee that the gums be red, the teeth white and even, and the brifket-fkin red, the wool firm, the breath fweet, and the feet not hot. Two years old is the beft time for beginning to breed; and their firft lambs fhould not be kept too long, to weaken them by fuckling, but be fold as foon as conveniently may be. They will breed advantageoufly till they are feven years old. The farmers have a method of knowing the age of a fheep, as a horfe's is known, by the mouth. When a fheep is one fhear, as they exprefs it, it has two broad teeth before; when it is two fhear, it will have four; when three, fix; and when four, eight. After this their mouths begin to break.

The difference of land makes a very great difference in the fheep. The fat paftures breed ftraight tall fheep, and the barren hills and downs breed fquare fhort ones; woods and mountains breed tall and flender fheep; but the beft of all are thofe bred upon new-ploughed land and dry grounds. On the contrary, all wet and moift lands are bad for fheep, efpecially fuch as are fubject to be overflowed, and to have fand and dirt left on them. The falt marfhes are, however, an exception to this general rule, for their faltnefs makes amends for their moifture; falt, by reafon of its drying quality, being of great advantage to fheep.

As to the time of putting the rams to the ewes, the farmer muft confider at what time of the fpring his grafs will be fit to maintain them and their lambs, and whether he has turnips to do it till the grafs comes; for very often both the ewes and lambs are deftroyed by the want of food; or if this does not happen, if the lambs are only ftinted in their growth by it, it is an accident that they never recover. The ewe goes 20 weeks with lamb, and according to this it is eafy to calculate the proper time. The beft time for them to yean is in April, unlefs the owner has very forward grafs or turnips, or the fheep are field fheep. Where you have not inclofures to keep them in, then it may be proper they fhould yean in January, that the lambs may be ftrong by May-day, and be able to follow the dam over the fallows and water-furrows; but then the lambs that come fo early muft have a great deal of care taken of them, and fo indeed fhould all other lambs at their firft falling, elfe while they are weak the crows and magpies will pick their eyes out.

14
When rams ought to be admitted to the ewes.

When the fheep are turned into fields of wheat or rye to feed, it muft not be too rank at firft, for if it be, it generally throws them into fcourings. Ewes that are big fhould be kept but bare, for it is very dangerous to them to be fat at the time of their bringing forth their young. They may be well fed, indeed, like cows, a fortnight beforehand, to put them in heart. Mortimer's Hufbandry, p. 243.

The

Sheep.

The feeding ſheep with turnips is one great advantage to the farmers. When they are made to eat turnips they ſoon fatten, but there is ſome difficulty in bringing this about. The old ones always refuſe them at firſt, and will ſometimes faſt three or four days, till almoſt famiſhed; but the young lambs fall to at once. The common way, in ſome places, of turning a flock of ſheep at large into a field of turnips, is very diſadvantageous, for they will thus deſtroy as many in a fortnight as would keep them a whole winter. There are three other ways of feeding them on this food, all of which have their ſeveral advantages.

15 The firſt way of feeding ſheep with turnips.

The firſt way is to divide the land by hurdles, and allow the ſheep to come upon ſuch a portion only at a time as they can eat in one day, and ſo advance the hurdles farther into the ground daily till all be eaten. This is infinitely better than the former random method; but they never eat them clean even this way, but leave the bottoms and outſides ſcooped in the ground: the people pull up theſe indeed with iron crooks, and lay them before the ſheep again, but they are commonly ſo fouled with the creature's dung and urine, and with the dirt from their feet, that they do not care for them; they eat but little of them, and what they do eat does not nouriſh them like the freſh roots.

16 The ſecond.

The ſecond way is by incloſing the ſheep in hurdles, as in the former; but in this they pull up all the turnips which they ſuppoſe the ſheep can eat in one day, and daily remove the hurdles over the ground whence they have pulled up the turnips: by this means there is no waſte, and leſs expence, for a perſon may in two hours pull up all thoſe turnips; the remaining ſhells of which would have employed three or four labourers a-day to get up with their crooks out of the ground trodden hard by the feet of the ſheep; and the worſt is, that as in the method of pulling up firſt, the turnips are eaten up clean, in this way, by the hook, they are waſted, the ſheep do not eat any great part of them, and when the ground comes to be tilled afterwards for a crop of corn, the fragments of the turnips are ſeen in ſuch quantities on the ſurface, that half the crop at leaſt ſeems to have been waſted.

17 The third, which is the beſt.

The third manner is to pull up the turnips, and remove them in a cart or waggon to ſome other place, ſpreading them on a freſh place every day; by this method the ſheep will eat them up clean, both root and leaves. The great advantage of this method is, when there is a piece of land not far off which wants dung more than that where the turnips grew, which perhaps is alſo too wet for the ſheep in winter, and then the turnips will, by the too great moiſture and dirt of the ſoil, ſometimes ſpoil the ſheep, and give them the rot. Yet ſuch ground will often bring forth more and larger turnips than dry land, and when they are carried off, and eaten by the ſheep on ploughed land, in dry weather, and on green ſward in wet weather, the ſheep will ſucceed much better; and the moiſt ſoil where the turnips grew not being trodden by the ſheep, will be much fitter for a crop of corn than if they had been fed with turnips on it. The expence of hurdles, and the trouble of moving them, are ſaved in this caſe, which will counterbalance at leaſt the expence of pulling the turnips and carrying them to the places where they are to be eaten. They muſt always be carried off for oxen.

18 Diſeaſes of ſheep.

The diſeaſes to which ſheep are ſubject are theſe, rot, red-water, foot-rot and hoving, ſcab, dunt, rickets, fly-ſtruck, flux, and burſting. Of each of theſe we ſhall give the beſt deſcription in our power, with the moſt approved remedies.

19 The rot.

The *rot*, which is a very pernicious diſeaſe, has of late engaged the attention of ſcientific farmers. But neither its nature nor its cauſe has yet been fully aſcertained. Some valuable and judicious obſervations have, however, been made upon it, which ought to be circulated, as they may perhaps, in many caſes, furniſh an antidote for this malignant diſtemper, or be the means of leading others to ſome more efficacious remedy. Some have ſuppoſed the rot owing to the quick growth of graſs or herbs that grow in wet places. Without premiſing, that all bounteous Providence has given to every animal its peculiar taſte, by which it diſtinguiſhes the food proper for its preſervation and ſupport, if not vitiated by fortuitous circumſtances, it ſeems very difficult to diſcover on philoſophical principles why the quick growth of graſs ſhould render it noxious, or why any herb ſhould at one ſeaſon produce fatal effects, by the admiſſion of pure water only into its component parts, which at other times is perfectly innocent, although brought to its utmoſt ſtrength and maturity by the genial influence of the ſun. Beſides, the conſtant practice of moſt farmers in the kingdom, who with the greateſt ſecurity feed their meadows in the ſpring, when the graſs ſhoots quick and is full of juices, militates directly againſt this opinion.

Mr Arthur Young aſcribes this diſeaſe to moiſture. In confirmation of this opinion, which has been generally adopted, we are informed, in the Bath Society papers*, by a correſpondent, that there was a paddock adjoining to his park which had for ſeveral years cauſed the rot in moſt of the ſheep which were put into it. In 1769 he drained it, and from that time his ſheep were free from this malady. But there are facts which render it doubtful that moiſture is the ſole cauſe. We are told, the dry limed land in Derbyſhire will produce the rot as well as water meadows and ſtagnant marſhes; and that in ſome wet grounds ſheep ſuſtain no injury for many weeks.

* Vol. I. art. xlvi.

20 Its cauſe.

Without attempting to enumerate other hypotheſes which the ingenious have formed on this ſubject, we ſhall purſue a different method in order to diſcover the cauſe. On diſſecting ſheep that die of this diſorder, a great number of inſects called *flukes* (ſee FASCIOLA) are found in the liver. That theſe flukes are the cauſe of the rot, therefore, is evident; but to explain how they come into the liver is not ſo eaſy. It is probable that they are ſwallowed by the ſheep along with their food while in the egg ſtate. The eggs depoſited in the tender germ are conveyed with the food into the ſtomach and inteſtines of the animals, whence they are received into the lacteal veſſels, carried off in the chyle, and paſs into the blood; nor do they meet with any obſtruction until they arrive at the capillary veſſels of the liver. Here, as the blood filtrates through the extreme branches, anſwering to thoſe of the *vena porta* in the human body, the ſecerning veſſels are too minute to admit the impregnated ova, which, adhering to the membrane, produce thoſe animalculæ that feed upon the liver and deſtroy the ſheep. They much reſemble the flat fiſh called plaice, are ſometimes as large as a ſilver two pence, and are found both in the liver and in

Sheep. the pipe (anſwering to that of the *vena cava*) which conveys the blood from the liver to the heart.

The common and moſt obvious objection to that opinion is, that this inſect is never found but in the liver, or in ſome parts of the viſcera, of ſheep that are diſeaſed more or leſs; and that they muſt therefore be bred there. But this objection will loſe its force, when we conſider that many inſects undergo ſeveral changes, and exiſt under forms extremely different from each other. Some of them may therefore appear and be well known under one ſhape, and not known to be the ſame under a ſecond or third. The fluke may be the laſt ſtate of ſome aquatic animal which we at preſent very well know under one or other of its previous forms.

If this be admitted, it is eaſy to conceive that ſheep may, on wet ground eſpecially, take multitudes of theſe ova or eggs in with their food; and that the ſtomach and viſcera of the ſheep being a proper nidus for them, they of courſe hatch, and appearing in their fluke or laſt ſtate, feed on the liver of the animal, and occaſion this diſorder.

It is a ſingular fact, "that no ewe ever has the rot while ſhe has a lamb by her ſide." The reaſon of this may be, that the impregnated ovum paſſes into the milk, and never arrives at the liver. The rot is fatal to ſheep, hares, and rabbits, and ſometimes to calves; but never infeſts animals of a larger ſize.

21 and moſt approved cures.

Miller ſays that parſley is a good remedy for the rot in ſheep. Perhaps a ſtrong decoction of this plant, or the oil extracted from its ſeeds, might be of ſervice. Salt is alſo a uſeful remedy. It ſeems to be an acknowledged fact, that ſalt-marſhes never produce the rot. Salt indeed is pernicious to moſt inſects. Common ſalt and water expel worms from the human body; and ſea-weed, if laid in a garden, will drive away inſects; but if the ſalt is ſeparated by ſteeping it in the pureſt ſpring-water for a few days, it abounds with animalculæ of various ſpecies.

Liſle, in his book of huſbandry, informs us of a farmer who cured his whole flock of the rot by giving each ſheep a handful of Spaniſh ſalt for five or ſix mornings ſucceſſively. The hint was probably taken from the Spaniards, who frequently give their ſheep ſalt to keep them healthy. On ſome farms perhaps the utmoſt caution cannot always prevent this diſorder. In wet and warm ſeaſons the prudent farmer will remove his ſheep from the lands liable to rot. Thoſe who have it not in their power to do this may give each ſheep a ſpoonful of common ſalt, with the ſame quantity of flour, in a quarter of a pint of water, once or twice a-week. At the commencement of the rot the ſame remedy given four or five mornings ſucceſſively will in all probability effect a cure. The addition of the flour and water, it is ſuppoſed, not only abates the pungency of the ſalt, but diſpoſes it to mix with the chyle in a more gentle and efficacious manner.

A farmer of a conſiderable lordſhip in Bohemia viſiting the hot-wells of Carlſbad, related how he preſerved his flocks of ſheep from the mortal diſtemper which raged in the wet year 1760, of which ſo many periſhed. His preſervative was very ſimple and very cheap: "He fed them every night, when turned under a ſhed, cover, or ſtables, with haſhed fodder ſtraw; and, by eating it greedily, they all eſcaped." Sheep.

22 Red water.

"*Red water* is a diſorder moſt prevalent on wet grounds. I have heard (ſays Mr Arthur Young) that it has ſometimes been cured by tapping, as for a dropſy. This operation is done on one ſide of the belly towards the flank, juſt below the wool.

23 Foot-rot.

"The *foot-rot* and *hoving*, which is very common on low fenny grounds, is cured by keeping the part clean, and lying at reſt in a dry paſture."

24 Scab.

The *ſcab* is a cutaneous diſeaſe owing to an impurity of the blood, and is moſt prevalent in wet lands or in rainy ſeaſons. It is cured by tobacco-water, brimſtone, and alum, boiled together, and then rubbed over the ſheep. If only partial, tar and greaſe may be ſufficient. But the ſimpleſt and moſt efficacious remedy for this diſeaſe was communicated to the Society for the Encouragement of Arts, &c. by Sir Joſeph Banks.

25 Remedy recommended by Sir Joſeph Banks.

"Take one pound of quickſilver, half a pound of Venice turpentine, half a pint of oil of turpentine, and four pounds of hogs lard (c). Let them be rubbed in a mortar till the quickſilver is thoroughly incorporated with the other ingredients; for the proper mode of doing which, it may be proper to take the advice, or even the aſſiſtance, of ſome apothecary or other perſon uſed to make ſuch mixtures.

"The method of uſing the ointment is this: Beginning at the head of the ſheep, and proceeding from between the ears along the back to the end of the tail, the wool is to be divided in a furrow till the ſkin can be touched; and as the furrow is made, the finger ſlightly dipped in the ointment is to be drawn along the bottom of it, where it will leave a blue ſtain on the ſkin and adjoining wool: from this furrow ſimilar ones muſt be drawn down the ſhoulders and thighs to the legs, as far as they are woolly; and if the animal is much infected, two more ſhould be drawn along each ſide parallel to that on the back, and one down each ſide between the fore and hind legs.

"Immediately after being dreſſed, it is uſual to turn the ſheep among other ſtock, without any fear of the infection being communicated; and there is ſcarcely an inſtance of a ſheep ſuffering any injury from the application. In a few days the blotches dry up, the itching ceaſes, and the animal is completely cured: it is generally, however, thought proper not to delay the operation beyond Michaelmas.

"The *hippoboſca ovina*, called in Lincolnſhire *ſheep fagg*, an animal well known to all ſhepherds, which lives among the wool, and is hurtful to the thriving of ſheep both by the pain its bite occaſions and the blood it ſucks, is deſtroyed by this application, and the wool is not at all injured. Our wool-buyers purchaſe the fleeces on which the ſtain of the ointment is viſible, rather in preference to others, from an opinion that the uſe of it

(c) By ſome unaccountable miſtake the laſt ingredient, the four pounds of hogs lard, is omitted in the receipt publiſhed in the Tranſactions of the Society; a circumſtance that might be productive of bad effects.—The leaf which contained the receipt has ſince been cancelled, and a new one printed.

Sheep.

it having preſerved the animal from being vexed either with the ſcab or faggs, the wool is leſs liable to the defects of joints or knots; a fault obſerved to proceed from every ſudden ſtop in the thriving of the animal, either from want of food or from diſeaſe.

"This mode of curing was brought into that part of Lincolnſhire where my property is ſituated about 12 years ago, by Mr Stephenſon of Mareha *, and is now ſo generally received, that the ſcab, which uſed to be the terror of the farmers, and which frequently deterred the more careful of them from taking the advantage of paſturing their ſheep in the fertile and extenſive commons with which that diſtrict abounds, is no longer regarded with any apprehenſion: by far the moſt of them have their flock anointed in autumn, when they return from the common, whether they ſhow any ſymptoms of ſcab or not; and having done ſo, conclude them ſafe for ſome time from either giving or receiving infection. There are people who employ themſelves in the buſineſs, and contract to anoint our large ſheep at five ſhillings a ſcore, inſuring for that price the ſucceſs of the operation; that is, agreeing, in caſe many of the ſheep break out afreſh, to repeat the operation gratis even ſome months afterwards."

26 The dunt.

The *dunt* is a diſtemper cauſed by a bladder of water gathering in the head. No cure for this has yet been diſcovered.

27 Rickets.

The *rickets* is a hereditary diſeaſe for which no antidote is known. The firſt ſymptom is a kind of lightheadedneſs, which makes the affected ſheep appear wilder than uſual when the ſhepherd or any perſon approaches him. He bounces up ſuddenly from his lare, and runs to a diſtance, as though he were purſued by dogs. In the ſecond ſtage the principal ſymptom is the ſheep's rubbing himſelf againſt trees, &c. with ſuch fury as to pull off his wool and tear away his fleſh. "The diſtreſſed animal has now a violent itching in his ſkin, the effect of a highly inflamed blood; but it does not appear that there is ever any cutaneous eruption or ſalutary critical diſcharge. In ſhort, from all circumſtances, the fever appears now to be at its height."—The laſt ſtage of this diſeaſe "ſeems only to be the progreſs of diſſolution, after an unfavourable criſis. The poor animal, as condemned by Nature, appears ſtupid, walks irregularly (whence probably the name *rickets*), generally lies, and eats little: theſe ſymptoms increaſe in degree till death, which follows a general conſumption, as appears upon diſſection of the carcaſe; the juices and even ſolids having ſuffered a general diſſolution.

In order to diſcover the ſeat and nature of this diſeaſe, ſheep that die of it ought to be diſſected. This is ſaid to have been done by one gentleman, Mr Beal; and he found in the brain or membranes adjoining a maggot about a quarter of an inch long, and of a browniſh colour. A few experiments might eaſily determine this fact.

28 Fly-ſtruck.

The *fly-ſtruck* is cured by clipping the wool off as far as infected, and rubbing the parts dry with lime or wood-aſhes; curriers oil will heal the wounds, and prevent their being ſtruck any more; or they may be cured with care, without clipping, with oil of turpentine, which will kill all the vermin where it goes; but the former is the ſureſt way.

29 Flux.

The *flux* is another diſeaſe to which ſheep are ſubject. The beſt remedy is ſaid to be, to houſe the ſheep immediately when this diſtemper appears, to keep them very warm, and feed them on dry hay, giving them frequent glitters of warm milk and water. The cauſe of that diſtemper is either their feeding on wet lands, or on graſs that is become moſſy by the lands having been fed many years without being ploughed. When the farmer perceives his ſheep-walks to become moſſy, or to produce bad graſs, he ſhould either plough or manure with hot lime, making kilns either very near or in the ſheep walks, becauſe the hotter the lime is put on, the ſweeter the graſs comes up, and that early in the year.

30 And burſting.

Burſting, or as it is called in ſome places the *blaſt*, attacks ſheep when driven into freſh graſs or young clover. They overeat themſelves, foam at the mouth, ſwell exceedingly, breathe very quick and ſhort, then jump up, and inſtantly fall down dead. In this caſe, the only chance of ſaving their life is by ſtabbing them in the maw with an inſtrument made for the purpoſe. The inſtrument is a hollow tube, with a pointed weapon paſſing through it. A hole is made with the pointed weapon; which is immediately withdrawn, and the hole is kept open by inſerting the tube till the wind is diſcharged.

31 Account of the noſe-worms which infeſt ſheep.

Sheep are infeſted with worms in their noſe called *œſtrus oves*, and produced from the egg of a large two-winged fly. The frontal ſinuſes above the noſe in ſheep and other animals are the places where theſe worms live and attain their full growth. Theſe ſinuſes are always full of a ſoft white matter, which furniſhes theſe worms with a proper nouriſhment, and are ſufficiently large for their habitation; and when they have here acquired their deſtined growth, in which they are fit to undergo their changes for the fly-ſtate, they leave their old habitation, and, falling to the earth, bury themſelves there; and when theſe are hatched into flies, the female, when ſhe has been impregnated by the male, knows that the noſe of a ſheep or other animal is the only place for her to depoſit her eggs, in order to their coming to maturity. Mr Valliſnieri, to whom the world owes ſo many diſcoveries in the inſect claſs, is the firſt who has given any true account of the origin of theſe worms. But though their true hiſtory had been till that time unknown, the creatures themſelves were very early diſcovered, and many ages ſince were eſteemed great medicines in epilepſies.

The fly produced from this worm has all the time of its life a very lazy diſpoſition, and does not like to make any uſe either of its legs or wings. Its head and corſelet together are about as long as its body, which is compoſed of five rings, ſtreaked on the back; a pale yellow and brown are there diſpoſed in irregular ſpots; the belly is of the ſame colours, but they are there more regularly diſpoſed, for the brown here makes three lines, one in the middle, and one on each ſide, and all the intermediate ſpaces are yellow. The wings are nearly of the ſame length with the body, and are a little inclined in their poſition, ſo as to lie upon the body: they do not, however, cover it; but a naked ſpace is left between them. The ailerous or petty wings which are found under each of the wings are of a whitiſh colour, and perfectly cover the balancers, ſo that they are not to be ſeen without lifting up theſe.

The fly will live two months after it is firſt produced, Sheep ‖ Sheers.

ced, but will take no nourishment of any kind; and possibly it may be of the same nature with the butterflies, which never take any food during the whole time of their living in that state. Reaumur, Hist. Inf. vol. iv. p. 552, &c.

32 Composition for marking sheep.

To find a proper composition for marking sheep is a matter of great importance, as great quantities of wool are every year rendered useless by the pitch and tar with which they are usually marked. The requisite qualities for such a composition are, that it be cheap, that the colour be strong and lasting, so as to bear the changes of weather, and not to injure the wool. Dr Lewis recommends for this purpose melted tallow, with so much charcoal in fine powder stirred into it as is sufficient to make it of a full black colour, and of a thick consistence. This mixture, being applied warm with a marking iron, on pieces of flannel, quickly fixed or hardened, bore moderate rubbing, resisted the sun and rain, and yet could be washed out freely with soap, or ley, or stale urine. In order to render it still more durable, and prevent its being rubbed off, with the tallow may be melted an eighth, sixth, or fourth, of its weight of tar, which will readily wash out along with it from the wool. Lewis's Com. Phil. Techn. p. 361.

SHEEP-Stealing. See THEFT.

SHEERING, in the sea-language. When a ship is not steered steadily, they say she sheers, or goes sheering; or when, at anchor, she goes in and out by means of the current of the tide, they also say she sheers.

SHEERNESS, a fort in Kent, seated on the point where the river Medway falls into the Thames. It was built by King Charles II. after the insult of the Dutch, who burnt the men of war at Chatham. The buildings belonging to it, in which the officers lodge, make a pretty little neat town; and there is also a yard and a dock, a chapel and a chaplain. Mr Lyons, who sailed with the honourable Captain Phipps in his voyage towards the pole, fixed the longitude of Sheerness to 0. 48′. E. its latitude 51° 25′.

SHEERS, a name given to an engine used to hoist or displace the lower masts of a ship. The sheers employed for this purpose in the royal navy are composed of several long masts, whose heels rest upon the side of the hulk, and having their heads declining outward from the perpendicular, so as to hang over the vessel whose masts are to be fixed or displaced. The tackles, which extend from the head of the mast to the sheer-heads, are intended to pull in the latter toward the mast-head, particularly when they are charged with the weight of a mast after it is raised out of any ship, which is performed by strong tackles depending from the sheer-heads. The effort of these tackles is produced by two capsterns, fixed on the deck for this purpose.

In merchant ships this machine is composed of two masts or props, erected in the same vessel wherein the mast is to be planted, or from whence it is to be removed. The lower ends of these props rest on the opposite sides of the deck, and their upper parts are fastened across, so as that a tackle which hangs from the intersection may be almost perpendicularly above the station of the mast to which the mechanical powers are applied. These sheers are secured by stays which extend forward and aft to the opposite extremities of the vessel.

Sheet ‖ Sheffield.

SHEERS, aboard a ship, an engine used to hoist or displace the lower masts of a ship.

SHEET-LEAD. See PLUMBERY.

SHEET, in sea-language, a rope fastened to one or both the lower corners of a sail, to extend and retain it in a particular station. When a ship sails with a lateral wind, the lower corner of the main and fore sail are fastened by a tack and a sheet; the former being to windward, and the latter to leeward; the tack, however, is entirely diffused with a stern wind, whereas the sail is never spread without the assistance of one or both of the sheets. The stay-sails and studding sails have only one tack and one sheet each: the stay-sail tacks are always fastened forward, and the sheet drawn aft; but the studding-sail tack draws the under clue of the sail to the extremity of the boom, whereas the sheet is employed to extend the inmost.

SHEFFIELD, a town in the west riding of Yorkshire, about 162 miles from London, is a large, thriving town on the borders of Derbyshire, with a population of 31,314 souls; has a fine stone bridge over the Don, and another over the Sheaf, and a church built in the reign of Henry I. It had a castle built in the reign of Henry III. in which, or else in the manor-house of the Park, Mary queen of Scots was prisoner 16 or 17 years; but after the death of Charles I. it was with several others, by order of parliament demolished. In 1673 an hospital was erected here, and endowed with 200l. a-year. There is a charity-school for 30 boys, and another for 30 girls. This town has been noted several hundred years for cutlers and smiths manufactures, which were encouraged and advanced by the neighbouring mines of iron, particularly for files, and knives or whittles; for the last of which especially it has been a staple for above 300 years; and it is reputed to excel Birmingham in these wares, as much as it is surpassed by it in locks, hinges, nails, and polished steel. The first mills in England for turning grindstones were also set up here. The houses look black from the continual smoke of the forges. Here are 600 master cutlers, incorporated by the style of the *Cutlers of Hallamshire* (of which this is reckoned the chief town), who employ no less than 40,000 persons in the iron manufactures; and each of the masters gives a particular stamp to his wares. There is a large market on Tuesday for many commodities, but especially for corn, which is bought up here for the whole west riding, Derbyshire, and Nottinghamshire. It has fairs on Tuesday after Trinity-Sunday, and November 28. In the new market-place, erected by the duke of Norfolk, the shambles are built upon a most excellent plan, and strongly inclosed. There are several other new good buildings, such as a large and elegant octagon chapel belonging to the hospital or alms-houses; likewise a good assembly-room and theatre. We must not omit the large steam-engine, lately finished, for the purpose of polishing and grinding the various sorts of hardware. The parish being very large, as well as populous, Mary I. incorporated 12 of the chief inhabitants, and their successors for ever, by the style of the *Twelve Capital Burgesses of Sheffield*, empowering them to elect and ordain three priests to assist the vicar, who were to be paid out of certain lands and rents which she gave out of the crown; and since this settlement two more chapels have been built in two hamlets of this parish,

rish, which are served by two of the assistants, while the third, in his turn, helps the vicar in his parish-church. James I. founded a free grammar school here, and appointed 13 school burgesses to manage the revenue, and appoint the master and usher. A new chapel was built lately by the contributions of the people of the town and of the neighbouring nobility and gentry. Water is conveyed by pipes into Sheffield, whose inhabitants pay but a moderate rent for it. In the neighbourhood there are some mines of alum. The remains of the Roman fortification between this town and Retheram, which is six miles lower down the river, are still visible; and here also is the famous trench of five miles long, by some called *Devil's* or *Dane's Bank*, and by others *Kemp Bank* and *Temple's Bank*. West Long. 1. 29. N. Lat. 13. 20.

SHEFFIELD, *John*, duke of Buckinghamshire, an eminent writer of the 17th and 18th century, of great personal bravery, and an able minister of state, was born about 1650. He lost his father at nine years of age; and his mother marrying Lord Offulston, the care of his education was left entirely to a governor, who did not greatly improve him in his studies. Finding that he was deficient in many parts of literature, he resolved to devote a certain number of hours every day to his studies; and thereby improved himself to the degree of learning he afterwards attained. Though possessed of a good estate, he did not abandon himself to pleasure and indolence, but entered a volunteer in the second Dutch war; and accordingly was in that famous naval engagement where the duke of York commanded as admiral: on which occasion his lordship behaved so gallantly, that he was appointed commander of the Royal Catharine. He afterward made a campaign in the French service under M. de Turenne. As Tangier was in danger of being taken by the Moors, he offered to head the forces which were sent to defend it; and accordingly was appointed to command them. He was then earl of Mulgrave, and one of the lords of the bed-chamber to King Charles II. The Moors retired on the approach of his majesty's forces; and the result of the expedition was the blowing up of Tangier. He continued in several great posts during the short reign of King James II. till that unfortunate prince was dethroned. Lord Mulgrave, though he paid his respects to King William before he was advanced to the throne, yet did not accept of any post in the government till some years after. In the sixth year of William and Mary he was created marquis of Normanby in the county of Lincoln. He was one of the most active and zealous opposers of the bill which took away Sir John Fenwick's life; and exerted the utmost vigour in carrying through the Treason Bill, and the bill for Triennial Parliaments. He enjoyed some considerable posts under King William, and enjoyed much of his favour and confidence. In 1702 he was sworn lord privy-seal; and in the same year was appointed one of the commissioners to treat of an union between England and Scotland. In 1703 he was created duke of Normanby, and soon after duke of Buckinghamshire. In 1711 he was made steward of her majesty's household, and president of the council. During Queen Anne's reign he was but once out of employment; and then he voluntarily resigned, being attached to what were called the *Tory principles*. Her majesty offered to make him lord chancellor; but he declined the office. He was instrumental in the change of the ministry in 1710. A circumstance that reflects the highest honour on him is, the vigour with which he acted in favour of the unhappy Catalans, who afterward were so inhumanly sacrificed. He was survived by only one legitimate son (who died at Rome in 1735); but left several natural children. He died in 1721. He was admired by the poets of his age; by Dryden, Prior, and Garth. His Essay on Poetry was applauded by Addison, and his Rehearsal is still read with pleasure. His writings were splendidly printed in 1723, in two volumes 4to; and have since been reprinted in 1729, in two volumes 8vo. The first contains his poems on various subjects; the second, his prose works; which consist of historical memoirs, speeches in parliament, characters, dialogues, critical observations, essays, and letters. It may be proper to observe, that the edition of 1729 is castrated; some particulars relating to the revolution in that of 1723 having given offence.

SHEFFIELDIA, a genus of plants belonging to the class of pentandria, and to the order of monogynia. The corolla is bell-shaped; the filaments are ten; of which every second is barren. The capsule consists of one cell, which has four valves. There is only one species, the *repens*, a native of New Zealand.

SHEIBON, a district in Africa, lying on the south-east of the kingdom of Dar-Fur, where much gold is found both in dust and in small pieces. The idolatrous natives and savages collect the dust in quills of the ostrich and vulture, and in that condition dispose of it to the merchants. On discovering a large piece of gold, they kill a sheep on it before it is removed. Their marriage is a simple agreement to cohabit. The slaves bought in great numbers from this quarter, are partly prisoners of war among themselves, and partly seduced by treachery, and sold. In times of scarcity, it is said, a father has been known to sell his children.

There are some Mahometans at Sheibon, who wear clothing, and live among the idolaters; but it is not said whether they are Arabs or not.

SHEIK, in the oriental customs, the person who has the care of the mosques in Egypt; his duty is the same as that of the imams at Constantinople. There are more or fewer of these to every mosque, according to its size or revenue. One of these is head over the rest, and answers to a parish-priest with us; and has under him, in large mosques, the readers, and people who cry out to go to prayers; but in small mosques the sheik is obliged to do all this himself. In such it is their business to open the mosque, to cry to prayers, and to begin their short devotions at the head of the congregation, who stand rank and file in great order, and make all their motions together. Every Friday the sheik makes an harangue to his congregation.

SHEIK-Bellet, the name of an officer in the Oriental nations. In Egypt the sheik-bellet is the head of a city, and is appointed by the pacha. The business of this officer is to take care that no innovations be made which may be prejudicial to the Porte, and that they send no orders which may hurt the liberties of the people. But all his authority depends on his credit and interest, not his office: for the government of Egypt is of such a kind, that often the people of the least power

by

by their posts have the greatest influence: and a caia of the janizaries or Arabs, and sometimes one of their meanest officers, an oda-basha, finds means, by his parts and abilities, to govern all things.

SHEILDS. See SHIELDS.

SHEKEL, the name of a weight and coin current among the ancient Jews. Dr Arbuthnot makes the weight of the shekel equal to 9 pennyweights $2\frac{4}{7}$ grains Troy weight; and the value equal to 2s. $3\frac{3}{8}$d. Sterling. The golden shekel was worth 1l. 16s. 6d.

SHELDRAKE. See ANAS, ORNITHOLOGY *Index*.

SHELF, among miners, the same with what they otherwise call *fast ground*, or *fast country*; being that part of the internal structure of the earth which they find lying even and in an orderly manner, and evidently retaining its primitive form and situation.

SHELL, in *Natural History*, a hard, and, as it were, stony covering, with which certain animals are defended, and thence called *shell fish*. For the classification and history, see CONCHOLOGY.

SHELLS, in *Gunnery*, are hollow iron balls to throw out of mortars or howitzers, with a fuse-hole of about an inch diameter, to load them with powder, and to receive the fuse. The bottom, or part opposite to the fuse, is made thicker than the rest, that the fuse may fall uppermost. But in small elevations this does not always happen, nor indeed is it necessary; for, let the shell fall as it will, the fuse sets fire to the powder within, which bursts the shell, and causes great devastation. The shells had much better be of an equal thickness; for then they burst into more pieces.

Message SHELLS, are nothing more than howitz-shells, in the inside of which a letter or other papers are put; the fuse hole is stopped up with wood or cork, and the shells are fired out of a royal or howitz, either into a garrison or camp. It is supposed, that the person to whom the letter is sent knows the time, and accordingly appoints a guard to look out for its arrival.

SHELL-Fish. These animals are in general oviparous, very few instances having been found of such as are viviparous. Among the oviparous kinds, anatomists have found that some species are of different sexes, in the different individuals of the same species; but others are hermaphrodites, every one being in itself both male and female. In both cases their increase is very numerous, and scarce inferior to that of plants, or of the most fruitful of the insect class. The eggs are very small, and are hung together in a sort of clusters by means of a glutinous humour, which is always placed about them, and is of the nature of the jelly of frog's spawn. By means of this, they are not only kept together in the parcel, but the whole cluster is fastened to the rocks, shells, or other solid substances; and thus they are preserved from being driven on shore by the waves, and left where they cannot succeed.

SHELL-Gold. See GOLD.

SHELTIE, a small but strong kind of horse, so called from Shetland, or Zetland, where they are produced.

SHELVES, in sea-language, a general name given to any dangerous shallows, sand banks, or rocks, lying immediately under the surface of the water, so as to intercept any ship in her passage, and endanger her destruction.

SHENAN. See *Dyeing of LEATHER*.

SHENSTONE, WILLIAM, an admired English poet, the eldest son of a plain country gentleman, who farmed his own estate in Shropshire, was born in November 1714. He learned to read of an old dame, whom his poem of the "School-mistress" has delivered to posterity; and soon received such delight from books, that he was always calling for new entertainment, and expected that, when any of the family went to market, a new book should be brought him, which, when it came, was in fondness carried to bed, and laid by him. It is said, that when his request had been neglected, his mother wrapped up a piece of wood of the same form, and pacified him for the night. As he grew older, he went for a while to the grammar-school in Hales Owen, and was placed afterwards with Mr Crumpton, an eminent school-master at Solihul, where he distinguished himself by the quickness of his progress. When he was young (June 1724), he was deprived of his father; and soon after (August 1726) of his grandfather; and was, with his brother, who died afterwards unmarried, left to the care of his grandmother, who managed the estate. From school he was sent, in 1732, to Pembroke college in Oxford, a society which for half a century has been eminent for English poetry and elegant literature. Here it appears that he found delight and advantage; for he continued his name there ten years, though he took no degree. After the first four years he put on the civilian's gown, but without showing any intention to engage in the profession. About the time when he went to Oxford, the death of his grandmother devolved his affairs to the care of the reverend Mr Dolman, of Brome, in Staffordshire, whose attention he always mentioned with gratitude. —At Oxford he applied to English poetry; and, in 1737, published a small Miscellany, without his name. He then for a time wandered about, to acquaint himself with life, and was sometimes at London, sometimes at Bath, or any place of public resort; but he did not forget his poetry. He published, in 1740, his "Judgement of Hercules," addressed to Mr Lyttleton, whose interest he supported with great warmth at an election; this was two years afterwards followed by the "School-mistress." Mr Dolman, to whose care he was indebted for his ease and leisure, died in 1745, and the care of his fortune now fell upon himself. He tried to escape it a while, and lived at his house with his tenants, who were distantly related; but, finding that imperfect possession inconvenient, he took the whole estate into his own hands, an event which rather improved its beauty than increased its produce. Now began his delight in rural pleasures, and his passion of rural elegance; but in time his expences occasioned clamours that overpowered the lamb's bleat and the linnet's song, and his groves were haunted by beings very different from fauns and fairies. He spent his estate in adorning it, and his death was probably hastened by his anxieties. He was a lamp that spent its oil in blazing. It is said, that if he had lived a little longer, he would have been assisted by a pension; such bounty could not have been more properly bestowed, but that it was ever asked is not certain; it is too certain that it never was enjoyed.—He died at the Leasowes, of a putrid fever, about five on Friday morning, Feb. 11. 1763; and was buried by the side of his brother, in the churchyard of Hales-Owen.

In his private opinions, our author adhered to no particular fect, and hated all religious difputes. Tendernefs, in every fenfe of the word, was his peculiar characteriftic; and his friends, domeftics, and poor neighbours, daily experienced the effects of his benevolence. This virtue he carried to an excefs that feemed to border upon weaknefs; yet if any of his friends treated him ungeneroufly, he was not eafily reconciled. On fuch occafions, however, he ufed to fay, "I never will be a revengeful enemy; but I cannot, it is not in my nature, to be half a friend." He was no economift; for the generofity of his temper prevented his paying a proper regard to the ufe of money: he exceeded therefore the bounds of his paternal fortune. But, if we confider the perfect paradife into which he had converted his eftate, the hofpitality with which he lived, his charities to the indigent, and all out of an eftate that did not exceed 300l. a-year, one fhould rather wonder that he left any thing behind him, than blame his want of economy: he yet left more than fufficient to pay all his debts, and by his will appropriated his whole eftate to that purpofe. Though he had a high opinion of many of the fair fex, he forbore to marry. A paffion he entertained in his youth was with difficulty furmounted. The lady was the fubject of that admirable paftoral, in four parts, which has been fo univerfally read and admired, and which, one would have thought, muft have foftened the proudeft and moft obdurate heart. His works have been publifhed by Mr Dodfley, in 3 vols 8vo. The firft volume contains his poetical works, which are particularly diftinguifhed by an amiable elegance and beautiful fimplicity; the fecond volume contains his profe works; the third his letters, &c. *Biog. Dict.*

SHEPPEY, an ifland at the mouth of the river Medway, about 20 miles in circumference. It is feparated from the main land by a narrow channel; and has a fertile foil, which feeds great flocks of fheep. The borough-town of Queenborough is feated thereon; befides which it has feveral villages.

SHERARDIA, a genus of plants belonging to the tetrandria clafs, and in the natural method ranking under the 47th order, *Stellatæ*. See BOTANY *Index*.

SHERBET, or SHERBIT, a compound drink, firft brought into England from Turkey and Perfia, confifting of water, lemon-juice, and fugar, in which are diffolved perfumed cakes made of excellent Damafcus fruit, containing an infufion of fome drops of rofe water. Another kind of it is made of violets, honey, juice of raifins, &c.

SHERIDAN, THOMAS, D. D. the intimate friend of Dean Swift, is faid by Shield, in Cibber's "Lives of the Poets," to have been born about 1684, in the county of Cavan, where, according to the fame authority, his parents lived in no very elevated ftate. They are defcribed as being unable to afford their fon the advantages of a liberal education; but he, being obferved to give early indications of genius, attracted the notice of a friend to his family, who fent him to the college of Dublin, and contributed towards his fupport while he remained there. He afterwards entered into orders, and fet up a fchool in Dublin, which long maintained a very high degree of reputation, as well for the attention beftowed on the morals of the fcholars as for their proficiency in literature. So great was the eftimation in which this feminary was held, that it is afferted to have produced in fome years the fum of 1000l. It does not appear that he had any confiderable preferment; but his intimacy with Swift, in 1725, procured for him a living in the fouth of Ireland worth about 150l. a-year, which he went to take poffeffion of, and, by an act of inadvertence, deftroyed all his future expectations of rifing in the church; for being at Corke on the 1ft of Auguft, the anniverfary of King George's birth-day, he preached a fermon, which had for its text, "Sufficient for the day is the evil thereof." On this being known, he was ftruck out of the lift of chaplains to the lord lieutenant, and forbidden the caftle.

This living Dr Sheridan afterwards changed for that of Dunboyne, which, by the knavery of the farmers, and power of the gentlemen in the neighbourhood, fell fo low as 80l. per annum. He gave it up for the free fchool of Cavan, where he might have lived well in fo cheap a country on 80l. a-year falary, befides his fcholars; but the air being, as he faid, too moift and unwholefome, and being difgufted with fome perfons who lived there, he fold the fchool for about 400l.; and having foon fpent the money, he fell into bad health, and died Sept. 10. 1738, in his 55th year.

Lord Corke has given the following character of him. "Dr Sheridan was a fchool-mafter, and in many inftances perfectly well adapted for that ftation. He was deeply verfed in the Greek and Roman languages, and in their cuftoms and antiquities. He had that kind of good nature which abfence of mind, indolence of body, and careleffnefs of fortune, produce; and although not over ftrict in his own conduct, yet he took care of the morality of his fcholars, whom he fent to the univerfity remarkably well founded in all kinds of claffical learning, and not ill inftructed in the focial duties of life. He was flovenly, indigent, and cheerful. He knew books much better than men; and he knew the value of money leaft of all. In this fituation, and with this difpofition, Swift faftened upon him as upon a prey with which he intended to regale himfelf whenever his appetite fhould prompt him." His Lordfhip then mentions the event of the unlucky fermon, and adds: "This ill-ftarred, good-natured, improvident man, returned to Dublin, unhinged from all favour at court, and even banifhed from the caftle. But ftill he remained a punfter, a quibbler, a fiddler, and a wit. Not a day paffed without a rebus, an anagram, or a madrigal. His pen and his fiddleftick were in continual motion; and yet to little or no purpofe, if we may give credit to the following verfes, which fhall ferve as the conclufion of his poetical character:

"With mufic and poetry equally blefs'd,
"A bard thus Apollo moft humbly addrefs'd;
"Great author of poetry, mufic, and light,
"Inftructed by thee, I both fiddle and write;
"Yet unheeded I fcrape, or I fcribble all day,
"My tunes are neglected, my verfe flung away.
"Thy fubftitute here, Vice-Apollo difdains
"To vouch for my numbers, or lift to my ftrains.
"Thy manual fign he refufes to put
"To the airs I produce from the pen or the gut:
"Be thou then propitious, great Phœbus, and grant
"Relief, or reward, to my merit or want.

Sheridan, Sheriff.

"Tho' the Dean and Delany tranſcendently ſhine,
"O! brighten one ſolo or ſonnet of mine:
"Make one work immortal, 'tis all I requeſt.
"Apollo look'd pleas'd, and reſolving to jeſt,
"Replied—Honeſt friend, I've conſider'd your caſe,
"Nor diſlike your unmeaning and innocent face.
"Your petition I grant, the boon is not great,
"Your works ſhall continue, and here's the receipt:
"On rondeaus hereafter your fiddle-ſtrings ſpend,
"Write verſes in circles, they never ſhall end."

"One of the volumes of Swift's miſcellanies conſiſts almoſt entirely of letters between him and the Dean. He publiſhed a proſe tranſlation of Perſius; to which he added the beſt notes of former editors, together with many judicious ones of his own. This work was printed at London, 1739, in 12mo. *Biog. Dict.*

SHERIDAN, *Mrs Frances*, wife to Thomas Sheridan, M. A. was born in Ireland about the year 1724, but deſcended from a good Engliſh family which had removed thither. Her maiden name was Chamberlaine, and ſhe was grand-daughter of Sir Oliver Chamberlaine. The firſt literary performance by which ſhe diſtinguiſhed herſelf was a little pamphlet at the time of a violent party-diſpute relative to the theatre, in which Mr Sheridan had newly embarked his fortune. So well-timed a work exciting the attention of Mr Sheridan, he by an accident diſcovered his fair patroneſs, to whom he was ſoon afterwards married. She was a perſon of the moſt amiable character in every relation of life, with the moſt engaging manners. After lingering ſome years in a very weak ſtate of health, ſhe died at Blois, in the ſouth of France, in the year 1767. Her "Sydney Biddulph" may be ranked with the firſt productions of that claſs in ours or in any other language. She alſo wrote a little romance in one volume called *Nourjahad*, in which there is a great deal of imagination productive of an admirable moral. And ſhe was the authoreſs of two comedies, "The Diſcovery" and "The Dupe."

Blackſt. Comment. vol. i. p. 339.

SHERIFF, an officer, in each county in England, nominated by the king, inveſted with a judicial and miniſterial power, and who takes place of every nobleman in the county during the time of his office.

The ſheriff is an officer of very great antiquity in this kingdom, his name being derived from two Saxon words, ſignifying the *reeve*, *bailiff*, or *officer* of the ſhire. He is called in Latin *vice-comes*, as being the deputy of the earl or *comes*, to whom the cuſtody of the ſhire is ſaid to have been committed at the firſt diviſion of this kingdom into counties. But the earls, in proceſs of time, by reaſon of their high employments and attendance on the king's perſon, not being able to tranſact the buſineſs of the county, were delivered of that burden; reſerving to themſelves the honour, but the labour was laid on the ſheriff. So that now the ſheriff does all the king's buſineſs in the county; and though he be ſtill called *vice-comes*, yet he is entirely independent of, and not ſubject to, the earl; the king, by his letters patent, committing *cuſtodiam comitatus* to the ſheriff, and to him alone.

Sheriffs were formerly choſen by the inhabitants of the ſeveral counties. In confirmation of which it was ordained, by ſtatute 28 Edw. I. c. 8. that the people ſhould have an election of ſheriffs in every ſhire where the ſhrievalty is not of inheritance. For anciently in ſome counties the ſheriffs were hereditary; as we apprehend they were in Scotland till the ſtatute 20 Geo. II. c. 43; and ſtill continue in the county of Weſtmoreland to this day; the city of London having alſo the inheritance of the ſhrievalty of Middleſex veſted in their body by charter. The reaſon of theſe popular elections is aſſigned in the ſame ſtatute, c. 13. "that the commons might chooſe ſuch as would not be a burden to them." And herein appears plainly a ſtrong trace of the democratical part of our conſtitution; in which form of government it is an indiſpenſable requiſite, that the people ſhould chooſe their own magiſtrates. This election was in all probability not abſolutely veſted in the commons, but required the royal approbation. For in the Gothic conſtitution, the judges of their county courts (which office is executed by the ſheriff) were elected by the people, but confirmed by the king: and the form of their election was thus managed; the people, or *incolæ territorii*, choſe twelve electors, and they nominated three perſons, *ex quibus rex unum confirmabat*. But, with us in England, theſe popular elections, growing tumultuous, were put an end to by the ſtatute 9. Edw. II. ſt. 2. which enacted, that the ſheriffs ſhould from thenceforth be aſſigned by the chancellor, treaſurer, and the judges; as being perſons in whom the ſame truſt might with confidence be repoſed. By ſtatutes 14 Edw. III. c. 7. 23 Hen. VI. c. 8. and 21 Hen. VIII. c. 20. the chancellor, treaſurer, preſident of the king's council, chief juſtices, and chief baron, are to make this election; and that on the morrow of All Souls, in the exchequer. And the king's letters patent, appointing the new ſheriffs, uſed commonly to bear date the ſixth day of November. The ſtatute of Cambridge, 12 Ric. II. c. 2. ordains, that the chancellor, treaſurer, keeper of the privy ſeal, ſteward of the king's houſe, the king's chamberlain, clerk of the rolls, the juſtices of the one bench and the other, barons of the exchequer, and all other that ſhall be called to ordain, name, or make juſtices of the peace, ſheriffs, and other officers of the king, ſhall be ſworn to act indifferently, and to name no man that ſueth to be put in office, but ſuch only as they ſhall judge to be the beſt and moſt ſufficient. And the cuſtom now is (and has been at leaſt ever ſince the time of Forteſcue, who was chief juſtice and chancellor to Henry the ſixth), that all the judges, together with the other great officers, meet in the exchequer chamber on the morrow of All Souls yearly, (which day is now altered to the morrow of St Martin, by the laſt act for abbreviating Michaelmas term), and then and there propoſe three perſons to the king, who afterwards appoints one of them to be ſheriff. This cuſtom of the twelve judges propoſing three perſons ſeems borrowed from the Gothic conſtitution before mentioned: with this difference, that among the Goths the 12 nominors were firſt elected by the people themſelves. And this uſage of ours, at its firſt introduction, there is reaſon to believe, was founded upon ſome ſtatute, though not now to be found among our printed laws; firſt, becauſe it is materially different from the direction of all the ſtatutes before-mentioned; which it is hard to conceive that the judges would have countenanced by their concurrence, or that Forteſcue would have inſerted in his book, unleſs by the authority of ſome ſtatute; and alſo, becauſe a ſtatute is expreſsly referred to in the record, which Sir Edward Coke tells

Sheriff. tells us he transcribed from the council book of 3d March, 34 Hen. VI. and which is in substance as follows. The king had of his own authority appointed a man sheriff of Lincolnshire, which office he refused to take upon him; whereupon the opinions of the judges were taken, what should be done in this behalf. And the two chief justices, Sir John Fortescue and Sir John Prisot, delivered the unanimous opinion of them all; "that the king did an error when he made a person sheriff that was not chosen and presented to him according to the statute; that the person refusing was liable to no fine for disobedience, as if he had been one of the three persons chosen according to the tenor of the statute; that they would advise the king to have recourse to the three persons that were chosen according to the statute, or that some other thrifty man be intreated to occupy the office for this year; and that, the next year, to eschew such inconveniences, the order of the statute in this behalf made be observed." But, notwithstanding this unanimous resolution of all the judges of England, thus entered in the council-book, and the statute 34 and 35 Hen. VIII. c. 26. § 61. which expressly recognizes this to be the law of the land, some of our writers have affirmed, that the king, by his prerogative, may name whom he pleases to be sheriff, whether chosen by the judges or not. This is grounded on a very particular case in the fifth year of Queen Elizabeth, when, by reason of the plague, there was no Michaelmas term kept at Westminster; so that the judges could not meet there *in crastino animarum* to nominate the sheriffs: whereupon the queen named them herself, without such previous assembly, appointing for the most part one of two remaining in the last year's list. And this case, thus circumstanced, is the only authority in our books for the making these extraordinary sheriffs. It is true, the reporter adds, that it was held that the queen by her prerogative might make a sheriff without the election of the judges, *non obstante aliquo statuto in contrarium;* but the doctrine of *non obstante*, which sets the prerogative above the laws, was effectually demolished by the bill of rights at the revolution, and abdicated Westminster-hall when King James abdicated the kingdom. However, it must be acknowledged, that the practice of occasionally naming what are called *pocket-sheriffs*, by the sole authority of the crown, hath uniformly continued to the reign of his present majesty; in which, it is believed, few (if any) instances have occurred.

Sheriffs, by virtue of several old statutes, are to continue in their office no longer than one year; and yet it hath been said that a sheriff may be appointed *durante bene placito*, or during the king's pleasure; and so is the form of the royal writ. Therefore, till a new sheriff be named, his office cannot be determined, unless by his own death, or the demise of the king; in which last case it was usual for the successor to send a new writ to the old sheriff; but now, by statute 1 Anne st. 1. c. 8 all officers appointed by the preceding king may hold their offices for six months after the king's demise, unless sooner displaced by the successor. We may farther observe, that by statute 1 Ric. II. c. 11. no man that has served the office of sheriff for one year can be compelled to serve the same again within three years after.

We shall find it is of the utmost importance to have the sheriff appointed according to law, when we consider his power and duty. These are either as a judge, as the keeper of the king's peace, as a ministerial officer of the superior courts of justice, or as the king's bailiff. Sheriff.

In his judicial capacity he is to hear and determine all causes of 40 shillings value and under, in his county-court: and he has also a judicial power in divers other civil cases. He is likewise to decide the elections of knights of the shire, (subject to the controul of the House of Commons), of coroners, and of verderors; to judge of the qualification of voters, and to return such as he shall determine to be duly elected.

As the keepers of the king's peace, both by common law and special commission, he is the first man in the county, and superior in rank to any nobleman therein, during his office. He may apprehend, and commit to prison, all persons who break the peace, or attempt to break it; and may bind any one in a recognizance to keep the king's peace. He may, and is bound, *ex officio*, to pursue and take all traitors, murderers, felons, and other misdoers, and commit them to gaol for safe custody. He is also to defend his county against any of the king's enemies when they come into the land; and for this purpose, as well as for keeping the peace and pursuing felons, he may command all the people of his county to attend him; which is called the *posse comitatus*, or power of the county; which summons, every person above 15 years old, and under the degree of a peer, is bound to attend upon warning, under pain of fine and imprisonment. But though the sheriff is thus the principal conservator of the peace in his county, yet, by the express directions of the great charter, he, together with the constable, coroner, and certain other officers of the king, are forbidden to hold any pleas of the crown, or, in other words, to try any criminal offence. For it would be highly unbecoming, that the executioners of justice should be also the judges; should impose, as well as levy, fines and amercements; should one day condemn a man to death, and personally execute him the next. Neither may he act as an ordinary justice of the peace during the time of his office; for this would be equally inconsistent, he being in many respects the servant of the justices.

In his ministerial capacity, the sheriff is bound to execute all process issuing from the king's courts of justice. In the commencement of civil causes, he is to serve the writ, to arrest, and to take bail; when the cause comes to trial, he must summon and return the jury; when it is determined, he must see the judgment of the court carried into execution. In criminal matters, he also arrests and imprisons, he returns the jury, he has the custody of the delinquent, and he executes the sentence of the court, though it extend to death itself.

As the king's bailiff, it is his business to preserve the rights of the king within his bailiwick; for so his county is frequently called in the writs: a word introduced by the princes of the Norman line; in imitation of the French, whose territory is divided into bailiwicks, as that of England into counties. He must seize to the king's use all lands devolved to the crown by attainder or escheat; must levy all fines and forfeitures; must seize and keep all waifs, wrecks, estrays, and the like, unless

Sheriff, Sherlock.

they be granted to some subject; and must also collect the king's rents within his bailiwick, if commanded by process from the exchequer.

To execute these various offices, the sheriff has under him many inferior officers; an under-sheriff, bailiffs, and gaolers, who must neither buy, sell, nor farm their offices, on forfeiture of 500l.

The under-sheriff usually performs all the duties of the office; a very few only excepted, where the personal presence of the high sheriff is necessary. But no under sheriff shall abide in his office above one year; and if he does, by statute 23 Hen. VI. c. 8. he forfeits 200l. a very large penalty in those early days. And no under-sheriff or sheriff's officer shall practise as an attorney during the time he continues in such office: for this would be a great inlet to partiality and oppression. But these salutary regulations are shamefully evaded, by practising in the names of other attorneys, and putting in sham deputies by way of nominal under-sheriffs: by reason of which, says Dalton, the under-sheriffs and bailiffs do grow so cunning in their several places, that they are able to deceive, and it may well be feared that many of them do deceive, both the king, the high sheriff, and the county.

SHERIFF, in Scotland. See LAW, Part iii. sect. 3.

SHERLOCK, WILLIAM, a learned English divine in the 17th century, was born in 1641, and educated at Eton school, where he distinguished himself by the vigour of his genius and his application to study. Thence he was removed to Cambridge, where he took his degrees. In 1669 he became rector of the parish of St George, Botolph-lane, in London; and in 1681 was collated to the prebend of Pancras, in the cathedral of St Paul's. He was likewise chosen master of the Temple, and had the rectory of Therfield in Hertfordshire. After the Revolution he was suspended from his preferment, for refusing the oaths to King William and Queen Mary; but at last he took them, and publicly justified what he had done. In 1691 he was installed dean of St Paul's. His Vindication of the Doctrine of the Trinity engaged him in a warm controversy with Dr South and others. Bishop Burnet tells us, he was "a clear, a polite, and a strong writer; but apt to assume too much to himself, and to treat his adversaries with contempt." He died in 1707. His works are very numerous; among these are, 1. A Discourse concerning the Knowledge of Jesus Christ, against Dr Owen. 2. Several pieces against the Papists, the Socinians, and Dissenters. 3. A practical Treatise on Death, which is much admired. 4. A practical Discourse on Providence. 5. A practical Discourse on the Future Judgment; and many other works.

SHERLOCK, *Dr Thomas*, bishop of London, was the son of the preceding Dr William Sherlock, and was born in 1678. He was educated in Catharine hall, Cambridge, where he took his degrees, and of which he became master: he was made master of the Temple very young, on the resignation of his father; and it is remarkable, that this mastership was held by father and son successively for more than 70 years. He was at the head of the opposition against Dr Hoadley bishop of Bangor; during which contest he published a great number of pieces. He attacked the famous Collins's "Grounds and Reasons of the Christian Religion," in a course of six sermons, preached at the Temple church, which he intitled "The Use and Intent of Prophecy in the several Ages of the World." In 1728, Dr Sherlock was promoted to the bishopric of Bangor; and was translated to Salisbury in 1734. In 1747 he refused the archbishopric of Canterbury, on account of his ill state of health; but recovering in a good degree, accepted the see of London the following year. On occasion of the earthquakes in 1750, he published an excellent Pastoral Letter to the clergy and inhabitants of London and Westminster: of which it is said there were printed in 4to, 5000; in 8vo, 20,000; and in 12mo, about 30,000; beside pirated editions, of which not less than 50,000 were supposed to have been sold. Under the weak state of body in which he lay for several years, he revised and published 4 vols of Sermons in 8vo, which are particularly admired for their ingenuity and elegance. He died in 1762, and by report worth 150,000l. "His learning," says Dr Nicholls, "was very extensive: God had given him a great and an understanding mind, a quick comprehension, and a solid judgment. These advantages of nature he improved by much industry and application. His skill in the civil and canon law was very considerable; to which he had added such a knowledge of the common law of England as few clergymen attain to. This it was that gave him that influence in all causes where the church was concerned; as knowing precisely what it had to claim from its constitutions and canons, and what from the common law of the land." Dr Nicholls then mentions his constant and exemplary piety, his warm and fervent zeal in preaching the duties and maintaining the doctrines of Christianity, and his large and diffusive munificence and charity; particularly by his having given large sums of money to the corporation of clergymen's sons, to several of the hospitals, and to the society for propagating the gospel in foreign parts: also his bequeathing to Catharine-hall in Cambridge, the place of his education, his valuable library of books, and his donations for the founding a librarian's place and a scholarship, to the amount of several thousand pounds.

Sherlock, Sherriffe.

SHERRIFFE of Mecca, the title of the descendants of Mahomet by Hassan Ibn Ali. These are divided into several branches, of which the family of Ali Bunemi, consisting at least of three hundred individuals, enjoy the sole right to the throne of Mecca. The Ali Bunemi are, again, subdivided into two subordinate branches, Darii Sajid, and Darii Barkad; of whom sometimes the one, sometimes the other, have given sovereigns to Mecca and Medina, when these were separate states.

Not only is the Turkish sultan indifferent about the order of succession in this family, but he seems even to foment the dissensions which arise among them, and favours the strongest, merely that he may weaken them all. As the order of succession is not determinately fixed, and the sherriffes may all aspire alike to the sovereign power, this uncertainty of right, aided by the intrigues of the Turkish officers, occasions frequent revolutions. The grand sherriffe is seldom able to maintain himself on the throne; and it still seldomer happens that his reign is not disturbed by the revolt of his nearest relations. There have been instances of a nephew succeeding his uncle, an uncle succeeding his nephew; and

and ſometimes of a perſon, from a remote branch, coming in the room of the reigning prince of the ancient houſe.

When Niebuhr was in Arabia, in 1763, the reigning Sherriffe Meſad had ſitten fourteen years on the throne, and, during all that period, had been continually at war with the neighbouring Arabs, and with his own neareſt relations ſometimes. A few years before, the pacha of Syria had depoſed him, and raiſed his younger brother to the ſovereign dignity in his ſtead. But after the departure of the caravan, Jafar, the new ſherriffe, not being able to maintain himſelf on the throne, was obliged to reſign the ſovereignty again to Meſad. Achmet, the ſecond brother of the ſherriffe, who was much beloved by the Arabs, threatened to attack Mecca while Niebuhr was at Jidda. Our traveller was ſoon after informed of the termination of the quarrel, and of Achmet's return to Mecca, where he continued to live peaceably in a private character.

Theſe examples ſhow that the Muſſulmans obſerve not the law which forbids them to bear arms againſt their holy places. An Egyptian bey even preſumed, a few years ſince, to plant ſome ſmall cannons within the compaſs of the Kaaba, upon a ſmall tower, from which he fired over that ſacred manſion, upon the palace of Sherriffe Meſad, with whom he was at variance.

The dominions of the ſherriffe, comprehend the cities of Mecca, Medina, Jambo, Taaif, Sadie, Ghunfude, Hali, and thirteen others leſs conſiderable, all ſituated in Hedjas. Near Taaif is the lofty mountain of Gazvan, which according to Arabian authors, is covered with ſnow in the midſt of ſummer. As theſe dominions are neither opulent nor extenſive, the revenue of their ſovereign cannot be conſiderable.

He finds a rich reſource, however, in the impoſts levied on pilgrims, and in the gratuities offered him by Muſſulman monarchs. Every pilgrim pays a tax of from ten to an hundred crowns, in proportion to his ability. The Great Mogul remits annually ſixty thouſand roupees to the ſherriffe, by an aſſignment upon the government of Surat. Indeed, ſince the Engliſh made themſelves maſters of this city, and the territory belonging to it, the nabob of Surat has no longer been able to pay the ſum. The ſherriffe once demanded it of the Engliſh, as the poſſeſſors of Surat; and, till they ſhould ſatisfy him, forbade their captains to leave the port of Jidda. But the Engliſh diſregarding this prohibition, the ſherriffe complained to the Ottoman Porte, and they communicated his complaints to the Engliſh ambaſſador. He at the ſame time opened a negociation with the nominal nabob, who reſides in Surat. But all theſe ſteps proved fruitleſs: and the ſovereign of Mecca ſeems not likely to be ever more benefited by the contribution from India.

The power of the ſherriffe extends not to ſpiritual matters; theſe are entirely managed by the heads of the clergy, of different ſects, who are reſident at Mecca. Rigid Muſſulmans, ſuch as the Turks, are not very favourable in their ſentiments of the ſherriffes, but ſuſpect their orthodoxy, and look upon them as ſecretly attached to the tolerant ſect of the Zeidi.

SHETLAND, the name of certain iſlands belonging to Scotland, and lying to the northward of Orkney. There are many convincing proofs that theſe iſlands were very early inhabited by the Picts, or rather by thoſe nations who were the original poſſeſſors of the Orkneys; and at the time of the total deſtruction of theſe nations, if any credit be due to tradition, their woods were entirely ruined (A). It is highly probable that the people in Shetland, as well as in the Orkneys, flouriſhed under their own princes dependent upon the crown of Norway; yet this ſeems to have been rather through what they acquired by fiſhing and commerce, than by the cultivation of their lands. It may alſo be reaſonably preſumed, that they grew thinner of inhabitants after they were annexed to the crown of Scotland; and it is likely that they revived again, chiefly by the very great and extenſive improvements which the Dutch made in the herring fiſhery upon their coaſts, and the trade that the crews of their buſſes, then very numerous, carried on with the inhabitants, neceſſarily reſulting from their want of proviſions and other conveniences.

There are many reaſons which may be aſſigned why theſe iſlands, though part of our dominions, have not hitherto been better known to us. They were commonly placed two degrees too far to the north in all the old maps, in order to make them agree with Ptolemy's deſcription of Thule, which he aſſerted to be in the latitude of 63 degrees; which we find urged by Camden as a reaſon why Thule muſt be one of the Shetland iſles, to which Speed alſo agrees, though from their being thus wrong placed he could not find room for them in his maps. Another, and that no light cauſe, was the many falſe, fabulous, and impertinent relations publiſhed concerning them (B), as if they were countries inhoſpitable and uninhabitable; and laſtly, the indolence, or rather indifference, of the natives, who, contenting themſelves with thoſe neceſſaries and conveniences procured by their intercourſe with other nations, and conceiving themſelves neglected by the mother country, have ſeldom troubled her with their applications.

There are few countries that have gone by more names than theſe iſlands; they were called in Iſlandic, *Hialtlandia*, from *hialt*, the "hilt of a ſword;" this might be poſſibly corrupted into *Hetland*, *Hitland*, or *Hethland*, though ſome tell us this ſignifies a "high land." They have been likewiſe, and are ſtill in ſome maps, called *Zetland* and *Zealand*, in reference, as has been ſuppoſed, to their ſituation. By the Danes, and by

(A) The tradition is, that this was done by the Scots when they deſtroyed the Picts; but is more probably referred to the Norwegians rooting out the original poſſeſſors of Shetland.

(B) They repreſented the climate as intenſely cold; the ſoil as compoſed of crags and quagmire, ſo barren as to be incapable of bearing corn; to ſupply which, the people, after drying fiſh-bones, powdered them, then kneaded and baked them for bread. The larger fiſh-bones were ſaid to be all the fuel they had. Yet, in ſo dreary a country, and in ſuch miſerable circumſtances, they were acknowledged to be very long-lived, cheerful, and contented.

Shetland. by the natives, they are ſtyled *Yealtaland:* and notwithſtanding the oddneſs of the orthography, this differs very little, if at all, from their manner of pronouncing Zetland, out of which pronunciation grew the modern names of *Shetland* and *Shotland*.

The iſlands of *Shetland*, as we commonly call them, are well ſituated for trade. The neareſt continent to them is Norway; the port of Bergen lying 44 leagues eaſt, whereas they lie 46 leagues north-north-eaſt from Buchanneſs; eaſt-north-eaſt from Sanda, one of the Orkneys, about 16 or 18 leagues; ſix or ſeven leagues north-eaſt from Fair Iſle; 58 leagues eaſt from the Ferroe iſles; and at nearly the ſame diſtance north-eaſt from Lewis. The ſouthern promontory of the Mainland, called *Sumburgh Head*, lies in 59 degrees and 59 minutes of north latitude; and the northern extremity of Unſt, the moſt remote of them all, in the latitude of 61 degrees 15 minutes. The meridian of London paſſes through this laſt iſland, which lies about 2 degrees 30 minutes weſt from Paris, and about 5 degrees 15 minutes eaſt from the meridian of Cape Lizard. According to Gifford's Hiſtorical Deſcription of Zetland, the inhabited iſlands are 33, of which the principal is ſtyled *Mainland*, and extends in length from north to ſouth about 60 miles, and is in ſome places 20 broad, though in others not more than two.

It is impoſſible to ſpeak with preciſion; but, according to the beſt computation which we have been able to form, the Shetland iſles contain near three times as much land as the Orkneys: and they are conſidered as not inferior to the provinces of Utrecht, Zealand, and all the reſt of the Dutch iſlands taken together; but of climate and ſoil they have not much to boaſt. The longeſt day in the iſland of Unſt is 19 hours 15 minutes, and of conſequence the ſhorteſt day 4 hours and 45 minutes. The ſpring is very late, the ſummer very ſhort; the autumn alſo is of no long duration, dark, foggy, and rainy; the winter ſets in about November, and laſts till April, and ſometimes till May. They have frequently in that ſeaſon ſtorms of thunder, much rain, but little froſt or ſnow. High winds are indeed very frequent and very troubleſome, yet they ſeldom produce any terrible effects. The aurora borealis is as common here as in any of the northern countries. In the winter ſeaſon the ſea ſwells and rages in ſuch a manner, that for five or ſix months their ports are inacceſſible, and of courſe the people during that ſpace have no correſpondence with the reſt of the world.

The ſoil in the interior part of the Mainland, for the moſt part, is mountainous, mooriſh, and boggy, yet not to ſuch a degree as to render the country utterly impaſſable; for many of the roads here, and in ſome of the northern iſles, are as good as any other natural roads, and the people travel them frequently on all occaſions. Near the coaſt there are ſometimes for miles together flat pleaſant ſpots, very fertile both in paſture and corn. The mountains produce large crops of very nutritive graſs in the ſummer; and they cut conſiderable quantities of hay, with which they feed their cattle in the winter. They might with a little attention bring more of their country into cultivation: but the people are ſo much addicted to their fiſhery, and feel ſo little neceſſity of having recourſe to this method for ſubſiſtence, that they are content, how ſtrange ſoever that may ſeem to us, to let four parts in five of their land remain in a ſtate of nature. Shetland.

They want not conſiderable quantities of marl in different iſlands, though they uſe but little; hitherto there has been no chalk found; limeſtone and freeſtone there are in the ſouthern parts of the Mainland in great quantities, and alſo in the neighbouring iſlands, particularly Fetlar; and conſiderable quantities of ſlate, very good in its kind. No mines have been hitherto wrought to any great extent; but there are in many places appearances of metallic ores, as thoſe of copper and iron; and it is ſaid, pieces of ſilver ore have been found. In ſome of the ſmaller iſles there are ſtrong appearances of iron; but, through the want of proper experiments being made, there is, in this reſpect at leaſt, hitherto nothing certain. Their meadows are incloſed with dikes, and produce very good graſs. The little corn they grow is chiefly barley, with ſome oats; though even in the northern extremity of Unſt the little land which they have is remarkable for its fertility. The hills abound with medicinal herbs; and their kitchen-gardens thrive as well, and produce as good greens and roots, as any in Britain. Of late years, and ſince this has been attended to, ſome gentlemen have had even greater ſucceſs than they expected in the cultivating of tulips, roſes, and many other flowers. They have no trees, and hardly any ſhrubs except juniper, yet they have a tradition that their country was formerly overgrown with woods; and it ſeems to be a confirmation of this, that the roots of timber-trees have been, and are ſtill, dug up at a great depth; and that in ſome, and thoſe too inacceſſible, places, the mountain-aſh is ſtill found growing wild. That this defect, viz. the want of wood at preſent, does not ariſe entirely from the ſoil or climate, appears from ſeveral late experiments; ſome gentlemen having raiſed aſh, maple, horſe-cheſnuts, &c. in their gardens. Though the inhabitants are without either wood or coals, they are very well ſupplied with fuel, having great plenty of heath and peat. The black cattle in this country are in general of a larger ſort than in Orkney, which is owing to their having more extenſive paſtures; a clear proof that ſtill farther improvements might be made in reſpect to ſize. Their horſes are ſmall, but ſtrong, ſtout, and well-ſhaped, live very hardy, and to a great age. They have likewiſe a breed of ſmall ſwine, the fleſh of which, when fat, is eſteemed very delicious. They have no goats, hares, or foxes; and in general no wild or venomous creatures of any kind except rats in ſome few iſlands. They have no moorfowl, which is the more remarkable, as there are everywhere immenſe quantities of heath; but there are many ſorts of wild and water-fowl, particularly the dunter-gooſe, clack-gooſe, ſolan-gooſe, ſwans, ducks, teal, whaps, ſoiſts, lyres, kittiwakes, maws, plovers, cormorants, &c. There is likewiſe the ember-gooſe, which is ſaid to hatch her egg under her wing. Eagles and hawks, as alſo ravens, crows, mews, &c. abound here.

All theſe iſlands are well watered; for there are everywhere excellent ſprings, ſome of them mineral and medicinal. They have indeed no rivers; but many pleaſant rills or rivulets, of different ſizes; in ſome of the largeſt they have admirable trouts, ſome of which are of 15 and even of 20 pounds weight. They have likewiſe

likewiſe many freſh-water lakes, well ſtored with trout and eels, and in moſt of them there are alſo large and fine flounders; in ſome very excellent cod. Theſe freſh-water lakes, if the country was better peopled, and the common people more at their eaſe, are certainly capable of great improvements. The ſea-coaſts of the Mainland of Shetland, in a ſtraight line, are 55 leagues; and therefore there cannot be a country conceived more proper for eſtabliſhing an extenſive fiſhery. What the inhabitants have been hitherto able to do, their natural advantages conſidered, does not deſerve that name, notwithſtanding they export large quantities of cod, tuſk, ling, and ſkate, inſomuch that the bounty allowed by acts of parliament amounts from 1400l. to 2000l. annually. They have, beſides, haddocks, whitings, turbot, and a variety of other fiſh. In many of the inlets there are prodigious quantities of excellent oyſters, lobſters, muſcles, cockles, and other ſhell-fiſh. As to amphibious creatures, they have multitudes of otters and ſeals; add to theſe, that amber, ambergris, and other ſpoils of the ocean, are ſometimes found upon the coaſts.

The inhabitants are a ſtout, well-made, comely people; the lower ſort of a ſwarthy complexion. The gentry are allowed, by all who have converſed with them, to be moſt of them polite, ſhrewd, ſenſible, lively, active, and intelligent perſons; and theſe, to the number of 100 families, have very handſome, ſtrong, well-built houſes, neatly furniſhed; their tables well ſerved; poliſhed in their manners, and exceedingly hoſpitable and civil to ſtrangers. Thoſe of an inferior rank are a hardy, robuſt, and laborious people, who, generally ſpeaking, get their bread by fiſhing in all weathers in their yawls, which are little bigger than Graveſend wherries; live hardily, and in the ſummer ſeaſon moſtly on fiſh; their drink, which, in reference to the Britiſh dominions, is peculiar to the country, is called *bland*, and is a ſort of butter-milk, long kept, and very ſour. Many live to great ages, though not ſo long as in former times. In reſpect, however, to the bulk of the inhabitants, from the poorneſs of living, from the nature of it, and from the drinking great quantities of corn-ſpirits of the very worſt ſort, multitudes are afflicted with an inveterate ſcurvy; from which thoſe in better circumſtances are entirely free, and enjoy as good health as in any other country in Europe. As they have no great turn to agriculture, and are perſuaded that their country is not fit for it, they do not (though probably they might) raiſe corn enough to ſupport them for more than two-thirds of the year. But they are much more ſucceſsful in their paſture-grounds, which are kept well incloſed, in good order, and, together with their commons, ſupply them plentifully with beef and mutton. They pay their rents generally in butter at Lammas, and in money at Martinmas. As to manufactures, they make a ſtrong coarſe cloth for their own uſe, as alſo linen. They make likewiſe of their own wool very fine ſtockings. They export, beſides the different kinds of fiſh already mentioned, ſome herrings, a conſiderable quantity of butter and train-oil, otter and ſeal ſkins, and no inconſiderable quantity of the fine ſtockings juſt mentioned. Their chief trade is to Leith, London, Hamburgh, Spain, and to the Straits. They import timbers, deals, and ſome of their beſt oats, from Norway; corn and flour from the Orkneys, and from North Britain; ſpirits and ſome other things from Hamburgh; cloths and better ſort of linen from Leith; grocery, houſehold furniture, and other neceſſaries, from London. The ſuperior-duties to the earl of Morton are generally let in farm; and are paid by the people in butter, oil, and money. The remains of the old Norwegian conſtitution are ſtill viſible in the diviſion of their lands; and they have ſome udalmen or freeholders amongſt them. But the Scots laws, cuſtoms, manners, dreſs, and language, prevail; and they have a ſheriff, and other magiſtrates for the adminiſtration of juſtice, as well as a cuſtomhouſe, with a proper number of officers. In reference to their eccleſiaſtical concerns, they have a preſbytery, 12 miniſters, and an itinerant for Foula, Fair Iſland, and the Skerries. Each of theſe miniſters has a ſtipend of between 40 and 50 pounds, beſides a houſe and a glebe free from taxes. The number of ſouls in theſe iſlands may be about 20,000.

SHEW-BREAD, the loaves of bread which the prieſt of the week put every Sabbath-day upon the golden-table in the ſanctuary, before the Lord, in the temple of the Jews. They were twelve in number, and were offered to God in the name of the twelve tribes of Iſrael. They were ſhaped like a brick, were ten palms long and five broad, weighing about eight pounds each. They were unleavened, and made of fine flour by the Levites. The prieſts ſet them on the table in two rows, ſix in a row, and put frankincenſe upon them to preſerve them from moulding. They were changed every Sabbath, and the old ones belonged to the prieſt upon duty. Of this bread none but the prieſts might eat, except in caſes of neceſſity. It was called the *bread of faces*, becauſe the table of the ſhew-bread, being almoſt over-againſt the ark of the covenant, the loaves might be ſaid to be ſet before the face of God. The original table was carried away to Babylon, but a new one was made for the ſecond temple. It was of wood overlaid with gold. This, with the candleſtick and ſome other ſpoils, was carried by Titus to Rome.

SHIELD, an ancient weapon of defence, in form of a light buckler, borne on the arm to fend off lances, darts, &c. The form of the ſhield is repreſented by the eſcutcheon in coats of arms. The ſhield was that part of the ancient armour on which the perſons of diſtinction in the field of battle always had their arms painted; and moſt of the words uſed at this time to expreſs the ſpace that holds the arms of families are derived from the Latin name for a ſhield, *ſcutum*. The French *eſcu* and *eſcuſſion*, and the Engliſh word *eſcutcheon*, or, as we commonly ſpeak it, *ſcutcheon*, are evidently from this origin; and the Italian *ſcudo* ſignifies both the ſhield of arms and that uſed in war. The Latin name *clypeus*, for the ſame thing, ſeems alſo to be derived from the Greek word γλυφειν, *to engrave*; and it had this name from the ſeveral figures engraved on it, as marks of diſtinction of the perſon who wore it.

The ſhield in war, among the Greeks and Romans, was not only uſeful in the defence of the body, but it was alſo a token, or badge of honour, to the wearer; and he who returned from battle without it was always treated with infamy afterwards. People have at all times thought this honourable piece of the armour the propereſt place to engrave, or figure on the ſigns of dignity of the poſſeſſor of it; and hence, when arms came to be painted for families in aftertimes, the heralds always

ways chose to represent them upon the figure of a shield, but with several exterior additions and ornaments; as the helmet, supporters, and the rest.

The form of the shield has not only been found different in various nations, but even the people of the same nation, at different times, have varied its form extremely; and among several people there have been shields of several forms and sizes in use, at the same period of time, and suited to different occasions. The most ancient and universal form of shields, in the earlier ages, seems to have been the triangular. This we see instances of in all the monuments and gems of antiquity: our own most early monuments show it to have been the most antique shape also with us, and the heralds have found it the most convenient for their purposes, when they had any odd number of figures to represent; as if three, then two in the broad bottom part, and one in the narrow upper end, it held them very well; or if five, they stood as conveniently, as three below, and two above. The other form of a shield, now universally used, is square, rounded and pointed at the bottom: this is taken from the figure of the Samnitic shield used by the Romans, and since copied very generally by the English, French, and Germans.

The Spaniards and Portuguese have the like general form of shields, but they are round at the bottom without the point; and the Germans, beside the Samnite-shield, have two others pretty much in use: these are, 1. The bulging shield, distinguished by its swelling or bulging out at the flanks; and, 2. The indented shield, or shield chancree, which has a number of notches and indentings all round its sides. The use of the ancient shield of this form was, that the notches served to rest the lance upon, that it might be firm while it gave the thrust; but this form being less proper for the receiving armorial figures, the two former have been much more used in the heraldry of that nation.

Beside this different form of the shields in heraldry, we find them also often distinguished by their different positions, some of them standing erect, and others slanting various ways, and in different degrees; this the heralds express by the word *pendant*, "hanging," they seeming to be hung up not by the centre, but by the right or left corner. The French call these *ecu pendant*, and the common antique triangular ones *ecu ancien*. The Italians call this *scuto pendente;* and the reason given for exhibiting the shield in these figures in heraldry is, that in the ancient tilts and tournaments, they who were to just at these military exercises, were obliged to hang up their shields with their armories, or coats of arms on them, out at the windows and balconies of the houses near the place; or upon trees, pavilions, or the barriers of the ground, if the exercise was to be performed in the field.

Those who were to fight on foot, according to Columbier, had their shields hung up by the right corner, and those who were to fight on horseback had theirs hung up by the left. This position of the shields in heraldry is called *couche* by some writers, though by the generality *pendant*.

It was very frequent in all parts of Europe, in arms given between the 11th and 14th centuries; but it is to be observed, that the hanging by the left corner, as it was the token of the owner's being to fight on horseback, so it was esteemed the most honourable and noble situation; and all the pendant shields of the sons of the royal family of Scotland and England, and of our nobility at that time, are thus hanging from the left corner. The hanging from this corner was a token of the owner's being of noble birth, and having fought in the tournaments before; but no sovereign ever had a shield pendant any way, but always erect, as they never formally entered the lists of the tournament.

The Italians generally have their shields of arms of an oval form; this seems to be done in imitation of those of the popes and other dignified clergy: but their herald Petro Sancto seems to regret the use of this figure of the shield, as an innovation brought in by the painters and engravers as most convenient for holding the figures, but derogatory to the honour of the possessor, as not representing either antiquity or honours won in war, but rather the honours of some citizen or person of learning. Some have carried it so far as to say, that those who either have no ancient title to nobility, or have sullied it by any unworthy action, cannot any longer wear their arms in shields properly figured, but were obliged to have them painted in an oval or round shield.

In Flanders, where this author lived, the round and oval shields are in the disrepute he speaks of; but in Italy, beside the popes and dignified prelates, many of the first families of the laity have them.

The secular princes, in many other countries, also retain this form of the shield, as the most ancient and truly expressive of the Roman clypeus.

SHIELD, in *Heraldry*, the escutcheon or field on which the bearings of coats of arms are placed. See HERALDRY.

SHIELDRAKE, or SHELDRAKE. See ANAS, ORNITHOLOGY *Index*.

SHIELDS, NORTH and SOUTH, two sea-port towns, at the mouth of the Tyne, the one in Northumberland, the other in the county of Durham. South Shields contained above 200 salt-pans, 50 years ago; but now there are not more than five or six; and the duty, which is now only 10,000l. per annum, amounted formerly to 80,000l. South Shields has a considerable trade, in which not less than 500 vessels from 100 to 500 tons burden are employed; and has nine dry docks for repairing, and 10 yards for building ships. This town has been much improved of late years. In the centre there is a large square, in which there is a handsome town-hall, with a colonnade under it for the weekly market, and from which streets branch out on all sides. North Shields contains also some fine streets and squares. The harbour is very commodious, and so spacious, that it is capable of receiving 2000 ships. It is defended by a fort, in which there is also a lighthouse, corresponding with another on the top of the bank, to direct vessels into the harbour. The population of North and South Shields is estimated at 25,000. W. Long. 1. 12. N. Lat. 55. 44.

SHIFTERS, on board a man of war, certain men who are employed by the cooks to shift and change the water in which the flesh or fish is put, and laid for some time, in order to fit it for the kettle.

SHIFTING A TACKLE, in sea-language, the act of removing the blocks of a tackle to a greater distance from each other, on the object to which they are applied, in order to give a greater scope or extent to their purchase. This operation is otherwise called *fleeting*. Shifting the helm denotes the alteration of its position, by

Shilling. by pushing it towards the opposite side of the ship. Shifting the voyal, signifies changing its position on the capstern, from the right to the left, and *vice versa*.

SHILLING, an English silver coin, equal to twelve pence, or the twentieth part of a pound.

Freherus derives the Saxon *scilling*, whence our shilling, from a corruption of *siliqua*; proving the derivation by several texts of law, and, among others, by the 26th law, *De annuis legatis*. Skinner deduces it from the Saxon *scild*, "shield," by reason of the escutcheon of arms thereon.

Bishop Hooper derives it from the Arabic *scheele*, signifying *a weight*; but others, with greater probability, deduce it from the Latin *sicilicus*, which signified in that language *a quarter of an ounce*, or the 48th part of a Roman pound. In confirmation of this etymology it is alleged, that the shilling kept its original signification, and bore the same proportion to the Saxon pound as sicilicus did to the Roman and the Greek, being exactly the 48th part of the Saxon pound; a discovery which we owe to Mr Lambarde *.

* *Explicatio Rerum et Verborum in Leg. Sax. voc. Libra.*

However, the Saxon laws reckon the pound in the round number at 50 shillings, but they really coined out of it only 48; the value of the shilling was fivepence; but it was reduced to fourpence above a century before the conquest; for several of the Saxon laws, made in Athelstan's reign, oblige us to take this estimate. Thus it continued to the Norman times, as one of the Conqueror's laws sufficiently ascertains; and it seems to have been the common coin by which the English payments were adjusted. After the conquest, the French *solidus* of twelvepence, which was in use among the Normans, was called by the English name of shilling; and the Saxon shilling of fourpence took a Norman name, and was called the *groat*, or great coin, because it was the largest English coin then known in England.

It has been the opinion of the bishops Fleetwood and Gibson, and of the antiquaries in general, that, though the method of reckoning by pounds, marks, and shillings, as well as by pence and farthings, had been in constant use even from the Saxon times, long before the Norman conquest, there never was such a coin in England as either a pound or a mark, nor any shilling, till the year 1504 or 1505, when a few silver shillings or twelvepences were coined, which have long since been solely confined to the cabinets of collectors.

Mr Clarke combats this opinion, alleging that some coins mentioned by Mr Folkes, under Edward I. were probably Saxon shillings new minted, and that Archbishop Aelfric expressly says †, that the Saxons had three names for their money, viz. mancuses, shillings, and pennies. He also urges the different value of the Saxon shilling at different times, and its uniform proportion to the pound, as an argument that their shilling was a coin; and the testimony of the Saxon gospels, in which the word we have translated *pieces of silver* is rendered *shillings*, which, he says, they would hardly have done, if there had been no such coin as a shilling then in use. Accordingly the Saxons expressed their shilling in Latin by *siclus* and *argenteus*. He farther adds, that the Saxon shilling was never expressed by *solidus* till after the Norman settlements in England; and howsoever it altered during the long period that elapsed from the conquest to the time of Henry VII. it was the most constant denomination of money in all payments, though it was then only a species of account, or the twentieth part of the pound sterling: and when it was again revived as a coin, it lessened gradually as the pound sterling lessened, from the 28th of Edward III. to the 43d of Elizabeth.

† *Gram. Saxon*, p. 52.

Shilling, Shilluk.

In the year 1560 there was a peculiar sort of shilling struck in Ireland, of the value of ninepence English, which passed in Ireland for twelvepence. The motto on the reverse was, *posui Deum adjutorem meum*. Eighty-two of these shillings, according to Malynes, went to the pound; they therefore weighed 20 grains, one-fourth each, which is somewhat heavier in proportion than the English shilling of that time, 62 whereof went to the pound, each weighing 92 grains seven-eighths; and the Irish shilling being valued at the Tower at ninepence English, that is, one-fourth part less than the English shilling, it should therefore proportionably weigh one-fourth part less, and its full weight be somewhat more than 62 grains; but some of them found at this time, though much worn, weighed 69 grains. In the year 1598, five different pieces of money of this kind were struck in England for the service of the kingdom of Ireland. These were shillings to be current in Ireland at twelvepence each; half shillings to be current at sixpence, and quarter shillings at threepence. Pennies and halfpennies were also struck of the same kind, and sent over for the payment of the army in Ireland. The money thus coined was of a very base mixture of copper and silver; and two years after there were more pieces of the same kinds struck for the same service, which were still worse; the former being three ounces of silver to nine ounces of copper; and these latter only two ounces eighteen pennyweights to nine ounces two pennyweights of the alloy.

The Dutch, Flemish, and Germans, have likewise their shilling, called *schelin*, *schilling*, *scalin*, &c. but these not being of the same weight or fineness with the English shilling, are not current at the same value. The English shilling is worth about 23 French sols; those of Holland and Germany about 11 sols and a half; those of Flanders about nine. The Dutch shillings are also called *sols de gros*, because equal to twelve gros. The Danes have copper shillings worth about one-fourth of a farthing sterling.

SHILLUK, a town in Africa on the banks of the true Nile. The houses are built of clay, and the clothing of the inhabitants consists of long grass, which they pass round the waist and between the thighs. They are all black, and both sexes shave their heads. These people have the dominion of the river, and exact toll of all passengers. The meaning of the word Shilluk seems to be unknown. When they transport Mahometans across the ferry, they sometimes shew the importance which their situation gives them. After the Mahometan has placed himself in the boat, they ask him, who is the master of that river? The other replies Ulloh or Rubbaric, God is the master of it. No, you must say that such a one (naming his chief) is the master of it, or you shall not pass. They are said to be hospitable to such as come among them in a peaceable manner, and as never betraying those to whom they have once afforded protection. The particulars of their worship have not been described. Shilluk, according to Mr Browne's map, is in 13° N. Lat. 3?° 26′ E. Long.

Shiloh.

SHILOH, is a term famous among interpreters and commentators upon Scripture. It is found (Gen. xlix. 10.) to denote the Messiah. The patriarch Jacob foretells his coming in these words; "The sceptre shall not depart from Judah, nor a lawgiver from between his feet, until Shiloh come; and unto him shall the gathering of the people be." The Hebrew text reads, יבא שלה עד כי *until Shiloh come*. All Christian commentators agree, that this word ought to be understood of the Messiah, or Jesus Christ; but all are not agreed about its literal and grammatical signification. St Jerome, who translates it by *Qui mittendus est*, manifestly reads *Shiloach* "sent," instead of *Shiloh*. The Septuagint have it Εως αν ελθη τα αποκειμενα αυτω; or, Εως αν ελθη ω αποκειται, (as if they had read שלו instead of שלה), i. e. "Until the coming of him to whom it is reserved;" or, "Till we see arive that which is reserved for him."

It must be owned, that the signification of the Hebrew word *Shiloh* is not well known. Some translate, "the sceptre shall not depart from Judah, till he comes to whom it belongs;" שלה or שלו instead of לו אשר. Others, "till the coming of the peace-maker;" or, "the pacific;" or, "of prosperity," שלה *prosperatus est*. *Shalah* signifies, "to be in peace, to be in prosperity;" others, "till the birth of him who shall be born of a woman that shall conceive without the knowledge of a man," שיל or שליא *secundina, fluxus* *; otherwise, "the sceptre shall not depart from Judah, till its end, its ruin; till the downfal of the kingdom of the Jews," שאל or שלה *it has ceased, it has finished* †. Some Rabbins have taken the name *Siloh* or *Shiloh*, as if it signified the city of this name in Palestine: "The sceptre shall not be taken away from Judah till it comes to Shiloh; till it shall be taken from him to be given to Saul at Shiloh." But in what part of Scripture is it said, that Saul was acknowledged as king or consecrated at Shiloh? If we would understand it of Jeroboam the son of Nebat, the matter is still as uncertain. The Scripture mentions no assembly at Shiloh that admitted him as king. A more modern author derives *Shiloh* from שלה. *fatigare*, which sometimes signifies *to be weary, to suffer*; "till his labours, his sufferings, his passion, shall happen."

* *Arab. Lud. de Dieu.*

† *Le Clerc in Genes.*

But not to amuse ourselves about seeking out the grammatical signification of Shiloh, it is sufficient for us to show, that the ancient Jews are in this matter agreed with the Christians: they acknowledge, that this word stands for the *Messiah the King*. It is thus that the paraphrasts Onkelos and Jonathan, that the ancient Hebrew commentaries upon Genesis, and that the Talmudists themselves, explain it. If Jesus Christ and his apostles did not make use of this passage to prove the coming of the Messiah, it was because then the completion of this prophecy was not sufficiently manifest. The sceptre still continued among the Jews; they had still kings of their own nation in the persons of the Herods; but soon after the sceptre was entirely taken away from them, and has never been restored to them since.

The Jews seek in vain to put forced meanings upon this prophecy of Jacob; saying, for example, that the sceptre intimates the dominion of strangers, to which they have been in subjection, or the hope of seeing one day the sceptre or supreme power settled again among themselves. It is easy to perceive, that all this is contrived to deliver themselves out of perplexity. In vain likewise they take refuge in certain princes of the captivity, whom they pretend to have subsisted beyond the Euphrates, exercising an authority over their nation little differing from absolute, and being of the race of David. This pretended succession of princes is perfectly chimerical; and though at certain times they could show a succession, it continued but a short time, and their authority was too obscure, and too much limited, to be the object of a prophecy so remarkable as this was.

Shiloh ‖ Ship.

SHINGLES, in building, small pieces of wood, or quartered oaken boards, sawn to a certain scantling, or, as is more usual, cleft to about an inch thick at one end, and made like wedges, four or five inches broad, and eight or nine inches long.

Shingles are used instead of tiles or slates, especially for churches and steeples; however, this covering is dear; yet, where tiles are very scarce, and a light covering is required, it is preferable to thatch; and where they are made of good oak, cleft, and not sawed, and well seasoned in water and the sun, they make a sure, light, and durable covering.

The building is first to be covered all over with boards, and the shingles nailed upon them.

SHIP, a general name for all large vessels, particularly those equipped with three masts and a bowsprit; the masts being composed of a lowermast, topmast, and top-gallant-mast: each of these being provided with yards, sails, &c. Ships, in general, are either employed for war or merchandise.

SHIPS of War are vessels properly equipped with artillery, ammunition, and all the necessary martial weapons and instruments for attack or defence. They are distinguished from each other by their several ranks or classes, called *rates*, as follows: Ships of the first rate mount from 100 guns to 110 guns and upwards; second rate, from 90 to 98 guns; third rate, from 64 to 74 guns; fourth rate, from 50 to 60 guns; fifth rate, from 32 to 44 guns; and sixth rates, from 20 to 28 guns. See the article RATE. Vessels carrying less than 20 guns are denominated *sloops, cutters, fire-ships* and *bombs*. It has lately been proposed to reduce the number of these rates, which would be a saving to the nation, and also productive of several material advantages.

In Plate CCCCLXXX. is the representation of a first rate, with rigging, &c. the several parts of which are as follows:

Plate CCCCLXXX. Fig. 1.

Parts of the hull.—Fig. 1. A, The cathead; B, The fore-chain-wales, or chains; C, The main-chains; D, The mizen-chains; E, The entering port; F, The hawse-holes; G, The poop-lanterns; H, The chess-tree; I, The head; K, The stern.

1, The bowsprit. 2, Yard and sail. 3, Gammoning. 4, Manrop. 5, Bobstay. 6, Spritsail-sheets. 7, Pendants. 8, Braces and pendants. 9, Halliards. 10, Lifts. 11, Clue-lines. 12, Spritsail-horses. 13, Buntlines. 14, Standing lifts. 15, Bowsprit-shroud. 16, Jib-boom. 17, Jibstay and sail. 18, Halliards. 19, Sheets. 20, Horses. 21, Jib-guy. 12, Spritsail-topsail yard. 23, Horses. 24, Sheets. 25, Lifts. 26, Braces and pendants. 27, Cap of bowsprit. 28, Jack staff. 29, Truck. 30, Jack flag.—31, *Foremast*. 32, Runner and tackle. 33, Shrouds. 34, Laniards. 35, Stay and laniard. 36, Preventer-stay and laniard. 37, Woolding of the mast. 38, Foreyard and sail. 39, Horses.

Ship. Horſes. 40, Top. 41, Crowfoot. 42, Jeers. 43, Yard-tackles. 44, Lifts. 45, Braces and pendants. 46, Sheets. 47, Foretacks. 48, Bowlines and bridles. 49, Fore buntlines. 50, Fore leechlines. 51, Preventer-brace. 52, Futtock-ſhrouds.—53, *Foretop-maſt.* 54, Shrouds and laniards. 55, Foretop-ſail yard and ſail. 56, Stay and ſail. 57, Runner. 58, Backſtays. 59, Halliards. 60, Lifts. 61, Braces and pendants. 62, Horſes. 63, Clew-lines. 64, Bowlines and bridles. 65, Reef-tackles. 66, Sheets. 67, Buntlines. 68, Croſs trees. 69, Cap. 70, Foretop-gallant-maſt. 71, Shrouds. 72, Yard and ſail. 73, Backſtays. 74, Stay. 75, Lifts. 76, Clewlines. 77, Braces and pendants. 78, Bowlines and bridles. 79, Flag-ſtaff. 80, Truck. 81, Flag-ſtay-ſtaff. 82, Flag of the lord high admiral.—83, *Mainmaſt.* 84, Shrouds. 85, Laniards. 86, Runner and tackle. 87, Futtock-ſhrouds. 88, Top-lantern. 89, Crank of ditto. 90, Stay. 91. Preventer-ſtay. 92, Stay-tackles. 93, Woolding of the maſt. 94, Jeers. 95, Yard-tackles. 96, Lifts. 97, Braces and pendants. 98, Horſes. 99, Sheets. 100, Tacks. 101, Bowlines and bridles. 102, Crow-foot. 103, Cap. 104, Top. 105, Buntlines. 106, Leechlines. 107, Yard and ſail.—108, *Main-topmaſt.* 109, Shrouds and laniards. 110, Yard and ſail. 111, Futtock-ſhrouds. 112, Backſtays. 113, Stay. 114, Stayſail and halliards. 115, Tye. 116, Halliards. 117, Lifts. 118, Clewlines. 119, Braces and pendants. 120, Horſes. 121, Sheets. 122, Bowlines and bridles. 123, Buntlines. 124, Reef-tackles. 125, Croſs-trees. 126, Cap.—127, *Maintop gallantmaſt.* 128, Shrouds and laniards. 129, Yard and ſail. 130, Backſtays. 131, Stay. 132, Stayſail and halliards. 133, Lifts. 134, Braces and pendants. 135, Bowlines and bridles, 136, Clewlines. 137, Flagſtaff. 138, Truck. 139 Flagſtaff-ſtay. 140, Flag ſtandard.—141, *Mizenmaſt.* 142, Shrouds and laniards. 143, Cap. 144, Yard and ſail. 145, Block for ſignal halliards. 146, Sheet, 147, Pendant lines. 148, Peekbrails. 149. Stayſail. 150, Stay. 151, Derrick and ſpan. 152, Top. 153, Croſsjack yard. 154, Croſsjack lifts. 155, Croſsjack braces. 156, Croſsjack ſlings.—157, *Mizentop-maſt.* 158, Shrouds and laniards. 159. Yard and ſail. 160, Backſtays. 161, Stay. 162, Halliards. 163, Lifts. 164, Braces and pendants. 165, Bowlines and bridles. 166, Sheets. 167, Clewlines. 168, Stayſail. 169, Croſstrees. 170, Cap. 171, Flagſtaff. 172, Flagſtaff-ſtay. 173, Truck. 174, Flag, union. 175, Enſign-ſtaff. 176, Truck. 177, Enſign. 178, Stern ladder. 179, Bower cable.

Plate CCCCLXXXI. Fig. 2. Fig. 2. Plate CCCCLXXXI. is a vertical longitudinal ſection of a firſt rate ſhip of war, with references to the principal parts, which are as follows:

A, Is the head, containing,—1, The ſtem; 2, The knee of the head or cutwater; 3, The lower and upper cheek; 4, The trail-board; 5, The figure; 6, The gratings; 7, The brackets; 8, The falſe ſtem; 9. The breaſt hooks; 10, The hauſe holes; 11, The bulkhead forward; 12, The cathead; 13, The cathook; 14, Neceſſary ſeats; 15, The manger within board; 16, The bowſprit.

B, Upon the forecaſtle—17, The gratings; 18, The partners of the maſt; 19, The gunwale; 20, The belfry; 21, The funnel for ſmoke; 22, The gangway going off the forecaſtle; 23, The forecaſtle guns.

C, In the forecaſtle—24, The door of the bulkhead forward; 25, Officers cabins; 26, Staircaſe; 27, Foretop-ſail ſheet bits; 28, The beams; 29, The carlings.

D, The middle gun deck forward—30, The forejeer bits; 31, The oven and furnace of copper; 32, The captain's cook room; 33, The ladder or way to the forecaſtle.

E, The lower gun-deck forward—34, The knees fore and aft; 35, The ſpirketings, or the firſt ſtreak next to each deck, the next under the beams being called *clamps;* 36. The beams of the middle gun deck fore and aft; 37, The carlings of the middle gun-deck fore and aft; 38, The fore-bits; 39, The after or main bits; 40. The hatchway to the gunner's and boatſwain's ſtore-rooms; 41. The jeer capſtan.

F, The orlop—42, 43, 44, The gunner's, boatſwain's, and carpenter's ſtore-rooms; 45, The beams of the lower gun-deck; 46, 47, The pillars and the riders, fore and aft; 48, The bulkhead of the ſtore-rooms.

G, The hold—49, 50, 51, The foot-hook rider, the floor rider, and the ſtandard, fore and aft; 52, The pillars; 53, The ſtep of the foremaſt; 54, The kelſon, or falſe keel, and dead riſing; 55, The dead-wood.

H, At midſhips in the hold—56, The floor timbers; 57, The keel; 58, The well; 59, The chain-pump; 60, The ſtep of the mainmaſt; 61, 62, Beams and carlings of the orlop, fore and aft.

I, The orlop amidſhips—63, The cable tire; 64, The main hatchway.

K, The lower gun-deck amidſhips—65, The ladder leading up to the middle gun-deck; 66, The lower tire of ports.

L, The middle gun-deck amidſhip—67, The middle tire of ports; 68, The entering port; 69, The main jeer bits; 70, Twiſted pillars or ſtanchions; 71, The capſtan; 72, Gratings; 73, The ladder leading to the upper deck.

M, The upper gun-deck amidſhips—74, The maintopſail-ſheet bits; 75, The upper partners of the mainmaſt; 76, The gallows on which ſpare topmaſts &c. are laid; 77, The foreſheet blocks; 78, The rennets; 79, The gunwale; 80, The upper gratings; 81, The drift brackets; 82, The piſs dale; 83, The capſtan pall.

N, Abaft the mainmaſt—84, The gangway off the quarterdeck; 85, The bulkhead of the coach; 86, The ſtaircaſe down to the middle gun-deck; 87, The beams of the upper deck; 88, The gratings about the mainmaſt; 89, The coach or council-chamber; 90, The ſtaircaſe up to the quarterdeck.

O, The quarterdeck—91, The beams; 92, The carlings; 93, The partners of the mizenmaſt; 94, The gangway up to the poop; 95, The bulkhead of the cuddy.

P, The poop—96, The trumpeter's cabin; 97, The taffarel.

Q, The captain's cabin.

R, The cuddy, uſually divided for the maſter and ſecretary's officers.

S, The ſtate-room, out of which is made the bedchamber and other conveniences for the commander in chief; 98, The entrance into the gallery; 99, The bulkhead of the great cabin; 100, The ſtern lights and after galleries.

T, The ward-room, allotted for the lieutenants and marine

Ship. marine officers: 101, The lower gallery; 102, The ſteerage and bulkhead of the wardroom; 103, The whipſtaff, commanding the tiller; 104, The after ſtaircaſe leading down to the lower gun-deck.

V, Several officers cabins abaft the mainmaſt, where the ſoldiers generally keep guard.

W, The gun room—105, The tiller commanding the rudder; 106, The rudder; 107, The ſtern-poſt; 108, The tiller tranſom; 109, The ſeveral tranſoms, viz. 1, 2, 3, 4, 5; 110, The gun-room ports, or ſtern-chaſe; 111, The bread-room ſcuttle, out of the gun-room; 112, The main capſtan; 113, The pall of the capſtan; 114, The partner; 115, The bulkhead of the bread-room.

X, The bread-room.

Y, The ſteward's room, where all proviſions are weighed and ſerved out.

Z, The cockpit, where are ſubdiviſions for the purſer, the ſurgeon, and his mates.

AA, The platform or orlop, where proviſion is made for the wounded in the time of ſervice; 116, The hold abaft the main-maſt; 117, The ſtep of the mizen-maſt; 118, The kelſon, or falſe keel; 119, The dead wood, or riſing.

Ships of war are fitted out either at the expence of the ſtate or by individuals. Thoſe fitted out at the public expence are called *King's ſhips*, and are divided into *ſhips of the line*, *frigates*, *ſloops*, &c. For an account of each of theſe, ſee the reſpective articles. Ships of war fitted out by individuals are called *privateers*. See the article PRIVATEER.

Armed SHIP. See *ARMED-Ship*.

Bomb-SHIP. See *BOMB Veſſels*.

Double-SHIP. See *SHIP-Building*.

Fire-SHIP. See *FIRE-Ship*.

Hoſpital-SHIP, a veſſel fitted up to attend on a fleet of men of war, and receive their ſick or wounded; for which purpoſe her decks ſhould be high, and her ports ſufficiently large. Her cables ought alſo to run upon the upper deck, to the end that the beds or cradles may be more commodiouſly placed between decks, and admit a free paſſage of the air to diſperſe that which is offenſive or corrupted.

Merchant-SHIP, a veſſel employed in commerce to carry commodities of various ſorts from one port to another.

The largeſt merchant ſhips are thoſe employed by the different companies of merchants who trade to the Eaſt Indies. They are in general larger than our 40 gun ſhips; and are commonly mounted with 20 guns on their upper-deck, which are nine pounders; and ſix on their quarter-deck, which are ſix pounders.

Regiſter-SHIP. See *REGISTER-Ship*.

Store-SHIP, a veſſel employed to carry artillery or naval ſtores for the uſe of a fleet, fortreſs, or garriſon.

Tranſport-SHIP, is generally uſed to conduct troops from one place to another.

Beſides the different kinds of ſhips abovementioned, which are denominated from the purpoſe for which they are employed, veſſels have alſo, in general, been named according to the different manner of rigging them. It would be an endleſs, and at the ſame time an unneceſſary taſk, to enumerate all the different kinds of veſſels with reſpect to their rigging; and therefore a few only are here taken notice of. Fig. 3. is a *ſhip* which would be converted into a *bark* by ſtripping the mizen maſt of its yards and the ſails belonging to them. If each maſt, its correſponding topmaſt and topgallant-maſt, inſtead of being compoſed of ſeparate pieces of wood, were all of one continued piece, then this veſſel with very little alteration would be a *polacre*. Fig. 4. repreſents a *ſnow*; fig. 5. a *bilander*; fig. 6. a *brig*; fig. 7. a *ketch*; fig. 8. a *ſchooner*; fig. 9. a *ſloop*; fig. 10. a *zebec*; fig. 11. a *galliot*; fig. 12. a *dogger*; fig. 13. a *galley* under ſail; fig. 14. ditto rowing.

Plate CCCCLXXX. Fig. 3.

Plate CCCCLXXXII. Fig. 6.

Ships are alſo ſometimes named according to the different modes of their conſtruction. Thus we ſay, a *cat-built* ſhip, &c.

To SHIP, is either uſed actively, as to embark any perſon or put any thing aboard ſhip: or paſſively, to receive any thing into a ſhip; as, "we ſhipped a heavy ſea at three o'clock in the morning."

To SHIP, alſo implies to fix any thing in its place; as, to ſhip the oars, that is, to put them in their row-locks; to ſhip the ſwivel guns, is to fix them in their ſockets; to ſhip the handſpokes, &c.

Machine for drawing Bolts out of SHIPS, an inſtrument invented by Mr William Hill for this purpoſe. His account of which is as follows*.

"Firſt, The uſe of this machine is to draw the kelſon and dead wood bolts out, and to draw the knee of the head bolts.—Secondly, The heads of the kelſon bolts heretofore were all obliged to be driven through the kelſon, floor-timbers, and keel, to get them out; by this means the kelſon is often entirely deſtroyed, and the large hole the head makes materially wounds the floors; and frequently, when the bolt is much corroded, it ſcarfs, and the bolt comes out of the ſide of the keel.—Thirdly, The dead-wood bolts that are driven with two or three drifts, are ſeldom or never got out, by which means the dead-wood is condemned, when ſome of it is really ſerviceable.—Fourthly, In drawing the knee of the head-bolts, ſometimes the knee ſtarts off, and cannot be got to again, but ſurs up, and with this machine may be drawn in; for it has been proved to have more power in ſtarting a bolt than the maul."

* *Tranſactions of the Society for the Encouragement of Arts, &c.* vol. xi.

In fig. 1. "A, A, repreſent two ſtrong male ſcrews, working in female ſcrews near the extremities of the cheeks, againſt plates of iron E, E. C C is the bolt to be drawn; which, being held between the chaps of the machine at DD, is, by turning the ſcrews by the lever B, forced upwards out of the wood or plank of the ſhip. F, F, are two dogs, with hooks at their lower extremities; which, being driven into the plank, ſerve to ſupport the machine till the chaps have got faſt hold of the bolt. At the upper part of theſe dogs are rings paſſing through holes in a collar, moveable near the heads of the ſcrews. Fig. 2. is a view of the upper ſide of the cheeks when joined together; *a*, *a*, the holes in which the ſcrews work; *b*, the chaps by which the bolts are drawn. Fig. 3. The under ſide of the cheek: *a*, *a*, the holes in which the ſcrews work; *b*, the chaps by which the bolts are drawn, and where the teeth that gripe the bolt are more diſtinctly ſhown. Fig. 4. One of the cheeks ſeparated from the other, the letters referring as in fig. 2. and 3.

Plate CCCCLXXXIII. Fig. 1. Fig. 2. Fig. 3. Fig. 4.

This machine was tried in his majeſty's yard at Deptford, and was found of the greateſt utility.—"Firſt, it drew a bolt that was driven down ſo tight as only to go one

Ship.

one inch in ſixteen blows with a double headed maul, and was well clenched below: the bolt drew the ring a conſiderable way into the wood, and wire drew itſelf through, and left the ring behind. Secondly, it drew a bolt out of the Venus's dead wood that could not be got out by the maul. That part of it which went through the keel was bent cloſe up to the lower part of the dead-wood, and the machine drew the bolt ſtraight, and drew it out with eaſe. It alſo drew a kelſon bolt out of the Stanley Weſt Indiaman, in Meſſrs Well's yard, Deptford; which being a bolt of two drifts, could not be driven out.

Management of SHIPS at ſingle anchor, is the method of taking care of a ſhip while riding at ſingle anchor in a tide-way, by preventing her from fouling her anchor, &c. The following rules for this purpoſe, with which we have been favoured by Henry Taylor * of North Shields, will be found of the utmoſt conſequence.

* *Taylor's Inſtructions to Young Mariners*

Riding at Anchor in moderate Weather.

Riding in a tide-way, with a freſh-of-wind, the ſhip ſhould have what is called *a ſhort* or *windward ſervice*, ſay 45 or 50 fathoms of cable, and always ſheered to windward (A), not always with the helm hard down, but more or leſs ſo according to the ſtrength or weakneſs of the tide. It is a known fact, that many ſhips ſheer their anchors home, drive on board of other ſhips, and on the ſands near which they rode, before it has been diſcovered that the anchor had been moved from the place where it was let go.

1
When the ſhip will back.

When the wind is croſs, or nearly croſs, off ſhore, or in the oppoſite direction, ſhips will always back. This is done by the mizen-topſail, aſſiſted, if needful, by the mizen ſtayſail; ſuch as have no mizen-topſail commonly uſe the main-topſail, or if it blows freſh, a topgallant-ſail, or any ſuch ſail at the gaff.

In backing, a ſhip ſhould always wind with a taught cable, that it may be certain the anchor is drawn round. In caſe there is not a ſufficiency of wind for that purpoſe, the ſhip ſhould be hove apeak.

2
How the yards ought to be braced.

Riding with the wind afore the beam, the yards ſhould be braced forward; if abaft the beam, they are to be braced all aback.

3
Riding windward tide in danger of breaking her ſheer.

If the wind is ſo far aft that the ſhip will not back (which ſhould not be attempted if, when the tide eaſes, the ſhip forges ahead, and brings the buoy on the lee quarter), ſhe muſt be ſet ahead: if the wind is far aft, and blows freſh, the utmoſt care and attention is neceſſary, as ſhips riding in this ſituation often break their ſheer, and come to windward of their anchors again. It ſhould be obſerved, that when the ſhip lies in this ticklish ſituation, the after-yards muſt be braced forward, and the fore-yards the contrary way: ſhe will lay ſafe, as the buoy can be kept on the lee quarter, or ſuppoſe the helm is aport, as long as the buoy is on the larboard quarter. With the helm thus, and the wind right aft, or nearly ſo, the ſtarboard main and fore braces ſhould be hauled in. This ſuppoſes the main braces to lead forward.

4
Tending to leeward when the ſhip muſt be ſet ahead.

When the ſhip begins to tend to leeward, and the buoy comes on the weather-quarter, the firſt thing to be done is to brace about the fore-yard; and when the wind comes near the beam, ſet the fore-ſtayſail, and keep it ſtanding until it ſhakes; then brace all the yards ſharp forward, eſpecially if it is likely to blow ſtrong.

5
How to manage when the ſhip breaks her ſheer.

If laying in the aforeſaid poſition, and ſhe breaks her ſheer, brace about the main-yard immediately; if ſhe recovers and brings the buoy on the lee or larboard quarter, let the main-yard be again braced about; but if ſhe come to a ſheer the other way, by bringing the buoy on the other quarter, change the helm and brace the fore-yard to.

6
When a long ſervice is out, and the ſhip is likely to go to windward.

Riding leeward tide with more cable than the windward ſervice, and expecting the ſhip will go to windward of her anchor, begin as ſoon as the tide eaſes to ſhorten in the cable. This is often hard work; but it is neceſſary to be done, otherwiſe the anchor may be fouled by the great length of cable the ſhip has to draw round; but even if that could be done, the cable would be damaged againſt the bows or cut-water. It is to be obſerved, that when a ſhip rides windward tide the cable ſhould be cackled from the ſhort ſervice towards the anchor, as far as will prevent the bare part touching the ſhip.

When the ſhip tends to windward and muſt be ſet ahead, hoiſt the fore-ſtayſail as ſoon as it will ſtand, and when the buoy comes on the lee quarter, haul down the fore-ſtayſail, brace to the fore-yard, and put the helm a-lee; for till then the helm muſt be kept a-weather and the yards full.

7
How to manage in a ſtorm.

When the ſhip rides leeward tide, and the wind increaſes, care ſhould be taken to give her more cable in time, otherwiſe the anchor may ſtart, and probably it will be troubleſome to get her brought up again; and this care is the more neceſſary when the ſhip rides in the hauſe of another ſhip. Previous to giving a long ſervice it is uſual to take a weather-bit, that is, a turn of the cable over the windlaſs end, ſo that in veering away the ſhip will be under command. The ſervice ought

(A) It has been thought by ſome theoriſts, that ſhips ſhould be ſheered to leeward of their anchors; but experience and the common practice of the beſt informed ſeamen are againſt that opinion: for it is found, that when a ſhip rides leeward tide and ſheered to windward, with the wind two or three points upon the bow, and blowing hard in the interval between the ſqualls, the ſheer will draw her towards the wind's eye; ſo that when the next ſquall comes, before ſhe be preſſed aſtream of her anchor, it is probable there will be a lull again, and the ſpring which the cable got by the ſheer will greatly eaſe it during the ſquall.

Every ſeaman knows that no ſhip without a rudder, or the helm left looſe, will wear; they always in ſuch ſituations fly to: this proves that the wind preſſing upon the quarter and the helm alee, a ſhip will be leſs liable to break her ſheer than when the helm is a-weather. Beſides, if the helm is a-lee when ſhe breaks her ſheer, it will be a-weather when the wind comes on the other quarter, as it ought to be until ſhe either ſwing to leeward, or bring the buoy on the other quarter. Now if the ſhip breaks her ſheer with the helm a-weather, it throws her head to the wind ſo ſuddenly as ſcarce to give time to brace the yards about, and very probably ſhe will fall over her anchor before the fore-ſtayſail can be got up.

ought to be greafed, which will prevent its chafing in the haufe.

If the gale continues to increafe, the topmafts fhould be ftruck in time; but the fore-yard fhould feldom, if ever, be lowered down, that in cafe of parting the forefail may be ready to be fet. At fuch times there fhould be more on deck than the common anchor-watch, that no accident may happen from inattention or falling afleep.

In a tide-way a fecond anchor fhould never be let go but when abfolutely neceffary; for a fhip will fometimes ride eafier and fafer, efpecially if the fea runs high, with a very long fcope of cable and one anchor, than with lefs length and two cables; however, it is advifable, as a preventive, when fhips have not room to drive, and the night is dark, to let fall a fecond anchor under foot, with a range of cable along the deck. If this is not thought neceffary to be done, the deep-fea lead fhould be thrown overboard, and the line frequently handled by the watch, that they may be affured fhe rides faft.

8
Caution refpecting the anchor watch.

If at any time the anchor-watch, prefuming on their own knowledge, fhould wind the fhip, or fuffer her to break her fheer without calling the mate, he fhould immediately, or the very firft opportunity, oblige the crew to heave the anchor in fight; which will prevent the commiffion of the like fault again; for befides the fhare of trouble the watch will have, the reft of the crew will blame them for neglecting their duty.

9
The particular duty of the chief mate.

Prudent mates feldom lie a week in a road-ftead without heaving their anchor in fight; even though they have not the leaft fufpicion of its being foul. There are other reafons why the anchor fhould be looked at; fometimes the cable receives damage by fweering wrecks or anchors that have been loft, or from rocks or ftones; and it is often neceffary to trip the anchor, in order to take a clearer birth, which fhould be done as often as any fhip brings up too near.

Method for the fafe removal of fuch SHIPS as have been driven on fhore. For this purpofe empty cafks are ufually employed to float off the veffel, efpecially if fhe is fmall, and at the fame time near the port to which it is propofed to conduct her. In other cafes, the following method adopted by Mr Barnard * will anfwer.

* *Philofophical Tranfactions*, vol. xx. part 1.

"On January 1. 1779 (fays Mr Barnard), in a moft dreadful ftorm, the York Eaft Indiaman, of eight hundred tons, homeward bound, with a pepper cargo, parted her cables in Margate roads, and was driven on fhore, within one hundred feet of the head and thirty feet of the fide of Margate pier, then drawing twenty-two feet fix inches water, the flow of a good fpring tide being only fourteen feet at that place.

"On the third of the fame month I went down, as a fhip-builder, to affift, as much as lay in my power, my worthy friend Sir Richard Hotham, to whom the fhip belonged. I found her perfectly upright, and her fheer (or fide appearance) the fame as when firft built, but funk to the twelve feet water-mark fore and aft in a bed of chalk mixed with a ftiff blue clay, exactly the fhape of her body below that draft of water; and from the rudder being torn from her as fhe ftruck coming on fhore, and the violent agitation of the fea after her being there, her ftern was fo greatly injured as to admit free accefs thereto, which filled her for four days equal to the flow of the tide. Having fully informed myfelf of her fituation and the flow of fpring-tides, and being clearly of opinion fhe might be again got off, I recommended, as the firft neceffary ftep, the immediate difcharge of the cargo; and, in the progrefs of that bufinefs, I found the tide always flowed to the fame height on the fhip; and when the cargo was half difcharged, and I knew the remaining part fhould not make her draw more than eighteen feet water, and while I was obferving the water at twenty-two feet fix inches by the fhip's marks, fhe inftantly lifted to feventeen feet eight inches; the water and air being before excluded by her preffure on the clay, and the atmofphere acting upon her upper part equal to fix hundred tons, which is the weight of water difplaced at the difference of thefe two drafts of water.

"The moment the fhip lifted, I difcovered fhe had received more damage than was at firft apprehended, her leaks being fuch as filled her from four to eighteen feet water in an hour and a half. As nothing effectual was to be expected from pumping, feveral fcuttles or holes in the fhip's fide were made, and valves fixed thereto, to draw off the water at the loweft ebb of the tide, to facilitate the difcharge of the remaining part of the cargo; and, after many attempts, I fucceeded in an external application of fheep-fkins fewed on a fail and thruft under the bottom, to ftop the body of water from rufhing fo furioufly into the fhip. This bufinefs effected, moderate pumping enabled us to keep the fhip to about fix feet water at low water, and by a vigorous effort we could bring the fhip fo light as (when the cargo fhould be all difcharged) to be eafily removed into deeper water. But as the external application might be difturbed by fo doing, or totally removed by the agitation of the fhip, it was abfolutely neceffary to provide fome permanent fecurity for the lives of thofe who were to navigate her to the river Thames. I then recommended as the cheapeft, quickeft, and moft effectual plan, to lay a deck in the hold, as low as the water could be pumped to, framed fo folidly and fecurely, and caulked fo tight, as to fwim the fhip independent of her own leaky bottom.

"Beams of fir-timber twelve inches fquare were placed in the hold under every lower-deck beam in the fhip, as low as the water would permit; thefe were in two pieces, for the conveniency of getting them down, and alfo for the better fixing them of an exact length, and well bolted together when in their places. Over thefe were laid long Dantzic deals of two inches and a half thick, well nailed and caulked. Againft the fhip's fides, all fore and aft, was well nailed a piece of fir twelve inches broad and fix inches thick on the lower and three inches on the upper edge, to prevent the deck from rifing at the fide. Over the deck, at every beam, was laid a crofs piece of fir timber fix inches deep and twelve inches broad, reaching from the pillar of the hold to the fhip's fide, on which the fhores were to be placed to refift the preffure of the water beneath. On each of thefe, and againft the lower-deck beam, at equal diftances from the fide and middle of the fhip, was placed an upright fhore, fix inches by twelve, the lower end let two inches into the crofs piece. From the foot of this fhore to the fhip's fide, under the end of every lower deck beam, was placed a diagonal fhore fix inches by twelve, to eafe the fhip's deck of part of the ftrain by throwing it on the fide. An upright fhore of three inches by twelve was placed from the end of every crofs piece

Ship.

piece to the lower deck beams at the ſide, and one of three inches by twelve on the midſhip end of every croſs piece to the lower deck beam, and nailed to the pillars in the hold. Two firm tight bulkheads or partitions were made as near the extremes of the ſhip as poſſible. The ceiling or inſide plank of the ſhip was very ſecurely caulked up to the lower deck, and the whole formed a complete ſhip with a flat bottom within ſide, to ſwim the outſide ſhip one; and that bottom being depreſſed ſix feet below the external water, reſiſted the ſhip's weight above it equal to five hundred and eighty-one tons, and ſafely conveyed her to the dry-dock at Deptford."

S H I P - B U I L D I N G.

1 Definition. SHIP-BUILDING, or Naval Architecture, is the art of conſtructing a ſhip ſo as to anſwer a particular purpoſe either of war or merchandiſe.

2 Hiſtory. To whom the world is indebted for the invention of ſhips, is, like all other things of equal antiquity, uncertain.

A very ſmall portion of art or contrivance was ſeen in the firſt ſhips: they were neither ſtrong nor durable; but conſiſted only of a few planks laid together, without beauty or ornament, and juſt ſo compacted as to keep out the water. In ſome places they were only the bulks or ſtocks of trees hollowed, and then conſiſted only of one piece of timber. Nor was wood alone applied to this uſe; but any other buoyant materials, as the Egyptian reed papyrus; or leather, of which the primitive ſhps were frequently compoſed; the bottom and ſides being extended on a frame of thin battens or ſcantlings, of flexible wood, or begirt with wickers, ſuch as we have frequently beheld amongſt the American ſavages. In this manner they were often navigated upon the rivers of Ethiopia, Egypt, and Sabæan Arabia, even in latter times. But in the firſt of them, we find no mention of any thing but leather or hides ſewed together. In a veſſel of this kind, Dardanus ſecured his retreat to the country afterwards called *Troas*, when he was compelled by a terrible deluge to forſake his former habitation of Samothrace. According to Virgil, Charon's infernal boat was of the ſame compoſition.

But as the other arts extended their influence, naval architecture likewiſe began to emerge from the gloom of ignorance and barbariſm; and as the ſhips of thoſe ages were increaſed in bulk, and better proportioned for commerce, the appearance of the floating citadels of unuſual form, full of living men, flying with ſeemingly expanded wings over the ſurface of the untravelled ocean, ſtruck the ignorant people with terror and aſtoniſhment: and hence, as we are told by Ariſtophanes, aroſe the fable of Perſeus flying to the Gorgons, who was actually carried thither in a ſhip! Hence, in all probability, the famous ſtory of Triptolemus riding on a winged dragon is deduced, only becauſe he ſailed from Athens, in the time of great dearth, to a more plentiful country, to ſupply the neceſſities of his people. The fiction of the flying horſe Pegaſus may be joined with theſe, who, as ſeveral mythologiſts report, was nothing but a ſhip with ſails, and thence ſaid to be the offspring of Neptune the ſovereign of the ſea; nor does there appear any other foundation for the ſtories of griffins, or of ſhips transformed into birds and fiſhes, which we ſo often meet with in the ancient poets. So acceptable to the firſt ages of the world were inventions of this nature, that whoever made any improvements in navigation or naval architecture, building new ſhips better fitted for ſtrength or ſwiftneſs than thoſe uſed before, or rendered the old more commodious by additional contrivances, or diſcovered countries unknown to former travellers, were thought worthy of the greateſt honours, and often aſſociated into the number of their deified heroes. Hence we have in aſtronomy the ſigns of Aries and Taurus, which were no other than two ſhips: the former tranſported Phryxus from Greece to Colchos, and the latter Europa from Phœnicia to Crete. Argo, Pegaſus, and Perſeus, were likewiſe new ſhips of a different ſort from the former, which being greatly admired by the barbarous and uninſtructed people of thoſe times, were tranſlated amongſt the ſtars, in commemoration of their inventors, and metamorphoſed into conſtellations by the poets of their own and of ſucceeding ages.

The chief parts, of which ſhips anciently conſiſted, were three, viz. the belly, the prow, and the ſtern: theſe were again compoſed of other ſmaller parts, which ſhall be briefly deſcribed in their order. In the deſcription, we chiefly follow Scheffer, who has ſo copiouſly treated this ſubject, and with ſuch induſtry and learning collected whatever is neceſſary to illuſtrate it, that very little room is left for enlargement by thoſe who incline to purſue this inveſtigation.

1. In the belly, or middle part of the ſhip, there was *τροπις*, *carina*, or the "keel," which was compoſed of wood: it was placed at the bottom of the ſhip, being deſigned to cut and glide through the waves, and therefore was not broad, but narrow and ſharp; whence it may be perceived that not all ſhips, but only the *μακραι*, which ſhips of war were called, whoſe bellies were ſtraight, and of a ſmall circumference, were provided with keels, the reſt having uſually flat bottoms. Around the outſide of the keel were fixed pieces of wood, to prevent it from being damaged when the ſhip was firſt launched into the water, or afterwards ſtruck on any rocks; theſe were called *χελευσματα*, in Latin *cunei*.

Next to the keel was *φαλκις* the "pump-well, or well-room," within which was contained the *αντλιον*, or "pump," through which water was conveyed out of the ſhip.

After this, there was *δευτερα τροπις*, or the "ſecond keel," ſomewhat reſembling what is now called *kelſon*; it was placed beneath the pump, and called *λεωσιον*, *χαλκηνε*, *κλειτοποδιον*; by ſome it is falſely ſuppoſed to be the ſame with *φαλκις*.

Above the pump was an hollow place, called by Herodotus *κοιλη της νηος*, by Pollux *κυτος* and *γαστρα*, becauſe large and capacious, after the form of a belly; by the Latins *teſtudo*. This was formed by crooked ribs, with which it was ſurrounded, which were pieces of wood riſing from the keel upwards, and called by Heſychius

νομε,

νομεις, and by others εγκοιλια, the belly of the ship being contained within them: in Latin, *costæ;* and in English, *timbers.* Upon these were placed certain planks, which Aristophanes calls εντερονειας, or εντερονιδα.

The πλευραι, *latera*, or "sides" of the ship, encompassed all the former parts on both hands; these were composed of large rafters extended from prow to stern, and called ζωστηρες, and ζωμαματα, because by them the whole fabric was begirt or surrounded.

In both these sides the rowers had their places, called τοιχοι and εδωλια, in Latin *fori* and *transtra*, placed above one another; the lowest was called θαλαμος, and those that laboured therein θαλαμιοι; the middle, ζυγα, and the men ζυγιοι; the uppermost θρανοι, whence the rowers were termed θρανιται. In these apartments were spaces through which the rowers put their oars: these were sometimes one continued vacuity from one end to the other, called τραφηξ, but more usually distinct holes, each of which was designed for a single oar; these were styled τρηματα, τρυπηματα, as also οφθαλμοι, because not unlike the eyes of living creatures. All of them were by a more general name termed εγκωπα, from containing the oars; but εγκωπιν seems to have been another thing, signifying the spaces between the banks of oars on each side, where the passengers appear to have been placed. On the top of all there was a passage or place to walk, called παραδος, and παραθρανος, as joining to the θρανοι, or uppermost bank of oars.

2. Πρωρα, the "prow, or fore deck," whence it is sometimes called μετωπον, and commonly distinguished by other metaphorical titles taken from human faces. In some ships there is mention of two prows, as also two sterns; such as Danaus's ship adorned by Minerva when he fled from Egypt. It was usual to beautify the prow with gold and various sorts of paint and colours; in the primitive times red was most in use; whence Homer's ships were generally dignified with the titles of μιλτοπαρηοι, and φοινικοπαρηοι, or "red faced;" the blue, likewise, or sky-colour, was frequently made use of, as bearing a strict resemblance to the colour of the sea; whence we find ships called by Homer κυανοπρωροι, by Aristophanes κυανεμβολοι. Several other colours were also made use of; nor were they barely varnished over with them, but very often annealed by wax melted in the fire, so that neither the sun, winds, nor water, were able to deface them. The art of doing this was called from the wax κηρογραφια, from the fire εγκαυστικη, which is described by Vitruvius, and mentioned in Ovid.

———*Picta coloribus ustis*
Cœruleam matrem concava puppis habet.

The painted ship with melted wax anneal'd
Had Tethys for its deity———

In these colours the various forms of gods, animals, plants, &c. were usually drawn, which were likewise often added as ornaments to other parts of the ships, as plainly appears from the ancient monuments presented to the world by Baysius.

The sides of the prow were termed πτερα, or "wings," and παρια, according to Scheffer, or rather παρειαι; for since the prow is commonly compared to a human face, it will naturally follow that the sides should be called *cheeks.* These are now called *bows* by our mariners.

3. Πρυμνη, "the hind-deck or poop," sometimes called ουρα, the "tail," because the hindmost part of the ship; it was of a figure more inclining to round than the prow, the extremity of which was sharp, that it might cut the waters; it was also built higher than the prow, and was the place where the pilot sat to steer; the outer-bending part of it was called επισειων, answering to our term *quarter.*

They had various ornaments of sculpture on the prow; as helmets, animals, triumphal wreaths, &c.— The stern was more particularly adorned with wings, shields, &c. Sometimes a little mast was erected whereon to hang ribbands of divers colours, which served instead of a flag to distinguish the ship; and a weather-cock, to signify the part from whence the wind blew.

On the extremity of the prow was placed a round piece of wood, called the πτυχις, from its bending; and sometimes οφθαλμος, the "eye" of the ship, because fixed in the fore-deck; on this was inscribed the name of the ship, which was usually taken from the figure painted on the flag. Hence comes the frequent mention of ships called *Pegasi*, *Scyllæ*, *bulls*, *rams*, *tigers*, &c. which the poets took the liberty to represent as living creatures that transported their riders from one country to another.

The whole fabric being completed, it was fortified with pitch, and sometimes a mixture of rosin, to secure the wood from the waters; whence it comes that Homer's ships are everywhere mentioned with the epithet of μελαιναι, or "black." Pitch was first used by the inhabitants of Phæacia, since called Corsica; sometimes wax was employed for the same purpose; whence Ovid,

Cœrulea ceratas accipit unda rates.

The azure waves receive the waxed ships.

After all, the ship being bedecked with garlands and flowers, the mariners also adorned with crowns, she was launched into the sea with loud acclamations and other expressions of joy; and being purified by a priest with a lighted torch, an egg and brimstone, or after some other manner, was consecrated to the god whose image she bore.

The ships of war of the ancients were distinguished from other kinds of vessels by various turrets and accessions of building, some to defend their own soldiers, and others to annoy the enemy; and from one another, in latter ages, by several degrees or ranks of oars, the most usual number of which was four or five, which appear not to have been arranged, as some imagine, on the same level in different parts of the ship; nor yet, as others have supposed, directly above one another's heads; but their seats being placed one behind another, ascended gradually, like stairs. Ptolemy Philopater, urged by a vain-glorious desire of exceeding all the world besides in naval architecture, is said to have farther enlarged the number of banks to 40; and the ship being otherwise in equal proportion, this raised her to such an enormous bulk, that she appeared at a distance like a floating mountain or island; and, upon a nearer view, like a prodigious castle on the ocean. She was 280 cubits long, 38 broad, and 48 high (each cubit being 1 English foot $5\frac{1}{2}$ inches), and carried 400 rowers, 400 sailors, and 3000 soldiers. Another which the same

History. same prince made to sail on the Nile, we are told, was half a stadium long. Yet these were nothing in comparison of Hiero's ship, built under the direction of Archimedes; on the structure of which Moschion wrote a whole volume. There was wood enough employed in it to make 50 galleys; it had all the variety of apartments of a palace; such as banqueting-rooms, galleries, gardens, fish-ponds, stables, mills, baths, and a temple to Venus. The floors of the middle apartment were all inlaid, and represented in various colours the stories of Homer's Iliad. The ceilings, windows, and all other parts, were finished with wonderful art, and embellished with all kinds of ornaments. In the uppermost apartment there was a spacious gymnasium, or place for exercise, and water was conveyed to the garden by pipes, some of hardened clay, and others of lead. The floors of the temple of Venus were inlaid with agates and other precious stones; the inside lined with cypress wood; the windows adorned with ivory paintings and small statues. There was likewise a library. This vessel was adorned on all sides with fine paintings. It had 20 benches of oars, and was encompassed with an iron rampart, eight towers, with walls and bulwarks, furnished with machines of war, particularly one which threw a stone of 300 pounds, or a dart 12 cubits long, the space of half a mile, with many other particulars related by Athenæus. Caligula likewise built a vessel adorned with jewels in the poop, with sails of many colours, and furnished with large porticoes, bagnios, and banqueting-rooms, besides rows of vines, and fruit-trees of various kinds. But these, and all such monstrous fabrics, served only for show and ostentation, being rendered by their vast bulk unwieldy and unfit for service. Athenæus informs us, the common names they were known by, were *Cyclades*, or *Ætna*, i. e. "islands, or mountains," to which they seemed nearly equal in bigness; consisting, as some report, of as many materials as would have composed 50 triremes, or ships of three banks.

The vessels employed by the northern nations appear to have been still more imperfect than those of the Romans; for a law was enacted in the reign of the emperor Honorius, 24th September, A. D. 418, inflicting capital punishment on any who should instruct the barbarians in the art of ship-building; a proof at once of the great estimation in which this science was then held, and of the ignorance of the barbarians with regard to it.

The fleet of Richard I. of England, when he weighed anchor for the holy war from Messina, in Sicily, where he had passed the winter, A. D. 1190-1, is said to have consisted of 150 great ships and 53 galleys, besides barks, tartans, &c. What kinds of ships these were is not mentioned. To the crusades, however pernicious in other respects, this science seems to owe some improvements; and to this particular one we are indebted for Richard's marine code, commonly called the *Laws of Oleron*, from the name of a small island on the coast of France, where he composed them, and which most of the nations in Europe have made the basis of their maritime regulations. Those ships, if they merited the name of ships, were probably very small, as we find that so long after as the time of Edward I. anno 1304, 40 men were deemed sufficient to man the best and largest vessels in England; and that Edward the Third, anno 1335, ordained the mayor and sheriffs of London to "take up all ships in their port, and all other ports in the kingdom, of the burden of 40 tons and upwards, and to furnish the same with armed men and other necessaries of war, against the Scots his enemies, confederated with certain persons of foreign nations." Edward the Third's fleet before Calais, anno 1347, consisted of 738 English ships, carrying 14,956 mariners, being on an average but 20 men to each ship; 15 ships and 459 mariners, from Bayonne in Guienne, being 30 men to each ship; 7 ships and 184 men from Spain, which is 26 men to each ship; one from Ireland, carrying 25 men; 14 from Flanders, with 133 men, being scarcely 10 men to each ship: and one from Guelderland, with 24 mariners. Fifteen of these were called the king's own ships, manned with 419 mariners, being somewhat under 17 to each ship.

Fœdera, vol. ii. p. 943.

Ib. vol. iv. p. 664.

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Historians represent the vessels of Venice and Genoa as the largest and the best about this time, but they were soon exceeded in size by the Spanish vessels called *carricks*, some of which carried cannon; and these again were exceeded by the vessels built by the northern people, particularly those belonging to the Hanse-towns.—In the 14th century, the Hanseatics were the sovereigns of the northern seas, as well without as within the Baltic; and their ships were so large, that foreign princes often hired them in their wars. According to Hakluyt, an English ship from Newcastle, of 200 tons burden, was seized in the Baltic by those of Wismar and Rostock, anno 1394; and another English vessel of the same burden was violently seized in the port of Lisbon, anno 1412.

Fœdera, vol viii. p. 727.

Soon after ships of a much larger size were constructed. It is mentioned that a very large ship was built, anno 1449, by John Taverner of Hull; and in the year 1455, King Henry IV. at the request of Charles king of Sweden, granted a licence for a Swedish ship of the burden of a thousand tons or under, laden with merchandize, and having 120 persons on board, to come to the ports of England, there to dispose of their lading, and to relade back with English merchandize, paying the usual customs. The inscription on the tomb of William Canning, an eminent merchant, who had been five times mayor of Bristol, in Ratcliff-church at Bristol, anno 1474, mentions his having forfeited the king's peace, for which he was condemned to pay 300 merks; in lieu of which sum, King Edward IV. took of him 2470 tons of shipping, amongst which there was one ship of 900 tons burden, another of 500 tons, and one of 400 tons, the rest being smaller.

Ib. vol. xi. p. 258.

Ib. vol xi. p. 364.

In the year 1506, King James IV. of Scotland built the largest ship which had hitherto been seen, but which was lost in her way to France in the year 1512, owing probably to a defective construction, and the unskilfulness of the crew in managing so large a ship.—About this time a very large ship was likewise built in France. In the fleet fitted out by Henry VIII. anno 1512, there was one ship, the Regent, of 1000 tons burden, one of 500, and three of 400 each. A ship still larger than the Regent was built soon after, called *Henri Grace Dieu!* In the year 1522 the first voyage round the globe was finished.

The English naval historians think that ships carried cannon on their upper decks only, and had no gunports before the year 1545: and it is certain that many

of

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of the largeſt ſhips in former times were fitted out from harbours, where ſhips of a moderate ſize now would not have water enough to float them. In 1575 the whole of the royal navy did not exceed 24 ſhips, and the number of merchant-ſhips belonging to England amounted to no more than 135 veſſels above 100 tons, and 656 between 40 and 100 tons. At Queen Elizabeth's death, anno 1603, there were not above four merchant-ſhips in England of 400 tons burden each.—The largeſt of Queen Elizabeth's ſhips of war was 1000 tons burden, carrying but 340 men, and 40 guns, and the ſmalleſt 600 tons, carrying 150 men and 30 guns. Smaller veſſels were occaſionally hired by her from private owners.

Monſon's Naval Tracts, p. 294.

In the memorable ſea-fight of Lepanto between the Turks and Chriſtians, anno 1571, no veſſels were employed but galleys; and it would appear from the carcaſes of ſome of them, which are ſtill preſerved in the arſenal at Venice, that even theſe were not ſo large or ſo well conſtructed as thoſe of our times. The Invincible Armada, as Spaniſh vanity ſtyled it, once the terror and admiration of nations, in the pompous and exaggerated deſcriptions of which the Spaniſh authors of thoſe times dwelt with ſo much apparent pleaſure, conſiſted of 130 ſhips, near 100 of which were the ſtatelieſt that had yet been ſeen on the ocean. The largeſt of theſe, however, would be no more than a third rate veſſel in our navy, and they were ſo ill conſtructed, that they would neither move eaſily, ſail near the wind, nor be properly worked in tempeſtuous weather. The whole of the naval force collected by Queen Elizabeth to oppoſe this formidable fleet, including hired veſſels, tenders, ſtore-ſhips, &c. amounted to no more than 143.

Ship-building began now to make a conſiderable progreſs in Britain. Both war and trade required an increaſe of ſhipping; ſo that, in the year 1670, the annual charge of the navy was reported to be 500,000l.; and in 1678 the navy conſiſted of 83 ſhips, of which 58 were of the line. At this time the exports amounted to ten millions per annum; and the balance of trade was two millions. In 1689 there were 173 ſhips, great and ſmall, in the royal navy, and it has been conſtantly increaſing; ſo that in 1761 the ſhips in the navy amounted to 372, of which 129 were of the line; and in the beginning of the year 1795, the total amount was above 430.

3 Ships of the common form found defective,

As ſhips of the common conſtruction are found to be very defective in many particulars, various methods have therefore from time to time been propoſed to remove ſome of the bad qualities they poſſeſſed. As it would be an endleſs taſk to enumerate the different inventions for this purpoſe, a few of them only will now be mentioned.

4 and improvements propoſed.

5 Double ſhips introduced by Sir William Petty, *European Magazine* for August 1752.

In 1663 Sir William Petty conſtructed a double ſhip, or rather a ſingle ſhip with a double bottom, which was found to ſail conſiderably faſter than any of the ſhips with which it had an opportunity of being tried. Her firſt voyage was from Dublin to Holyhead; and in her return "ſhe turned into that narrow harbour againſt wind and tide, among rocks and ſhips, with ſuch dexterity as many ancient ſeamen confeſſed they had never ſeen the like." This veſſel with 70 more was loſt in a dreadful tempeſt.

6 and again propoſed by Mr Gordon, p. 54.

This ſubject was again revived by Mr Gordon, in his Principles of Naval Architecture, printed at Aberdeen anno 1784; where, having delivered his ſentiments on the conſtruction of large maſts, he ſays: "Theſe experiments likewiſe point out to us methods by which two veſſels may be laterally connected together, though at a conſiderable diſtance from each other, in a manner ſufficiently ſtrong, with very little increaſe of weight or expence of materials, and without expoſing much ſurface to the action or influence of the wind or the waves, or obſtructing their motion in any conſiderable degree, and conſequently without being much oppoſed by them on that account under any circumſtances; and if veſſels are judiciouſly conſtructed with a view to ſuch a junction, it would be no eaſy matter to enumerate all the advantages that may be obtained by this means." He then enumerates the advantages that double veſſels would have over thoſe of the common conſtruction. Soon after double ſhips were actually built by Mr Miller of Dalſwinton.

7 And lately conſtructed by Mr Miller.

Principles of Naval Architecture, p. 76.

8 Draught of water propoſed to be diminiſhed in order to obtain velocity, &c.

Another plan was propoſed by Mr Gordon to make a ſhip ſail faſt, draw little water, and to keep a good wind. For this purpoſe, "the bottom (he ſays) ſhould be formed quite flat, and the ſides made to riſe perpendicular from it, without any curvature; which would not only render her more ſteady, as being more oppoſed to the water in rolling, but likewiſe more convenient for ſtowage, &c. while the ſimplicity of the form would contribute greatly to the eaſe and expedition with which ſhe might be fabricated. Though diminiſhing the draught of water is, *cæteris paribus*, undoubtedly the moſt effectual method of augmenting the velocity with which veſſels go before the wind; yet, as it proportionally diminiſhes their hold of the water, it renders them extremely liable to be driven to leeward, and altogether incapable of keeping a good wind. This defect may, however, be remedied, in a ſimple and effectual manner, by proportionally augmenting the depth of keel, or, as ſo large a keel would be inconvenient on many accounts, proportionally increaſing their number; as, in place of adding a keel eight feet deep to a veſſel drawing ſix feet water, to affix to different parts of her flat bottom, which would be well adapted for receiving them, ſix different keels of two feet deep each at equal diſtances from each other, with proper intervals between; which will be found equally effectual for preventing theſe pernicious effects. Four ſuch, indeed, would have anſwered the purpoſe as well as the eight feet keel, were it not for the ſuperior preſſure or reſiſtance of the lower water (A).

9 Inconveniency of this plan.

10 Remedied by augmenting the depth of the keel,

11 or by increaſing the number of keels.

Thus

(A) This is frequently repeated on the authority of Mr Gordon and others. Theory ſays otherwiſe; and the experiments of Sir Iſaac Newton ſhow in the moſt unexceptionable manner, that the reſiſtance of a ball deſcending through the water is the ſame at all depths; nay, the heaping up of the water on the bow, occaſioning a hydroſtatical preſſure in addition to the real reſiſtance, will make the whole oppoſition to an equal ſurface, but of greater horizontal dimenſions, greater, becauſe it bears a greater proportion to the reſiſtance.

Thus then it appears, that a veſſel drawing eight feet water only, keels and all, may be made to keep as good a wind, or be as little liable to be driven to leeward, as the ſharpeſt built veſſel of the ſame length drawing 14, nay 20 or upwards, if a few more keels are added, at the ſame time that ſhe would be little more reſiſted in moving in the line of the keels than a veſſel drawing ſix feet water only. Theſe keels, beſides, would ſtrengthen the veſſel conſiderably, would render her more ſteady, and leſs liable to be overſet, and thereby enable her to carry more ſail; and Mr Gordon then enumerates the ſeveral advantages that a ſhip of this conſtruction will poſſeſs.

12 The plan farther improved by the adoption of ſliding keels.

This plan has been put into execution by Captain Schank, with this difference only, that inſtead of the keels being fixed as propoſed by Mr Gordon, Captain Schank conſtructed them ſo as to ſlide down to a certain depth below the bottom, or to be drawn up within the ſhip as occaſion might require.

Captain Schank having communicated his plans to the Navy Board, two veſſels were in conſequence ordered to be built of 13 tons each, and ſimilar in dimenſions, one on the old conſtruction, and the other flat-bottomed, with ſliding keels. In 1790 a comparative trial in preſence of the commiſſioners of the navy was made on the river Thames, each having the ſame quantity of ſail; and although the veſſel on the old conſtruction had leeboards, a greater quantity of ballaſt, and two Thames pilots aboard, yet Captain Schank's veſſel with three ſliding keels beat the other veſſel, to the aſtoniſhment of all preſent, one half of the whole diſtance ſailed; and no doubt ſhe would have beat her much more had ſhe been furniſhed with a Thames pilot.

13 The utility of ſliding keels proved by experiment.

This trial gave ſo much ſatisfaction, that a king's cutter of 120 tons was immediately ordered to be built on the ſame conſtruction, and Captain Schank was requeſted to ſuperintend its building. This veſſel was launched at Plymouth in 1791, and named the *Trial*. The length of this veſſel is 66 feet, breadth 21 feet, and depth of the hold ſeven feet: her bottom is quite flat, and draws only ſix feet water, with all her guns, ſtores, &c. whereas all other veſſels of her tonnage on the old conſtruction draw 14 feet; ſo that ſhe can go with ſafety into almoſt any harbour or creek. She has three ſliding keels incloſed in a caſe or well; they are each 14 feet in length; the fore and the after keels are three feet broad each, and the middle keel is ſix feet broad. The keels are moveable by means of a winch, and may be let down ſeven feet below the real keel; and they work equally well in a ſtorm as in ſtill water. Her hold is divided into ſeveral compartments, all water-tight, and ſo contrived, that ſhould even a plank or two ſtart at ſea in different parts of the veſſel, ſhe may be navigated with the greateſt ſecurity to any place. If ſhe ſhould be driven on ſhore in a gale of wind, ſhe will not ſoon become a wreck, as her keels will be driven up into their caſes, and the ſhip being flat-bottomed, will not be eaſily overſet; and being able to go into ſuch ſhallow water, the crew may all be eaſily ſaved. By means of her ſliding keel ſhe is kept ſteady in the greateſt gale; ſhe is quite eaſy in a great ſea, does not ſtrain in the leaſt, and never takes in water on her deck; and when at anchor, ſhe rides more upright and even than any other ſhip can do: ſhe ſails very faſt either before or upon a wind; no veſſel ſhe has ever been in company with, of equal ſize, has been able, upon many trials, to beat her in ſailing; and yet her ſails ſeem too ſmall.

14 And actually put in practice upon a larger ſcale.

It has alſo been propoſed to conſtruct veſſels of other materials than wood; and a veſſel was built whoſe bottom, inſtead of being plank, was copper.

Book I. *Containing the Method of Delineating the ſeveral Sections of a Ship.*

Chap. I. *Of the Properties of Ships.*

15 General principles of ſhip-building.

A ship ought to be conſtructed ſo as to anſwer the particular purpoſe for which ſhe is intended. It would be an eaſy matter to determine the form of a ſhip intended to ſail by means of oars; but, when ſails are uſed, a ſhip is then acted upon by two elements, the wind and water: and therefore it is much more difficult than is commonly imagined to aſcertain the form of a ſhip ſo as to anſwer in an unfavourable as well as a favourable wind; the ſhip at the ſame time having a cargo of a certain weight and magnitude.

16 Properties that a ſhip muſt poſſeſs to be a good ſailer.

Every ſhip ought to ſail well, but particularly when the wind is upon the beam; for this purpoſe a conſiderable length in proportion to the breadth is neceſſary, and the plane of reſiſtance ſhould be the leaſt poſſible. The main frame ſhould alſo be placed in a proper ſituation; but according to the experiments of Mr Chapman *, its plane is variable with the velocity of the ſhip: the mean place of the main frame has, however, been generally eſtimated to be about one-twelfth of the length of the keel before the middle. Without a ſufficient degree of ſtability a ſhip will not be able to carry a preſs of ſail: a great breadth in proportion to the length and low upper-works will augment the ſtability. The following particulars being attended to, the above property will be gained, and the ſhip will alſo ſteer well. The wing tranſom ſhould be carried pretty high; the faſhion-pieces well formed, and not full below the load water-line: the lower part of the ſtem to be a portion of a circle, and to have a conſiderable rake: the ſternpoſt to be nearly perpendicular to the keel; and all the upper works kept as low as poſſible.

* *Traité de la Conſtruction des Vaiſſeaux*, p. 40.

17 To make a ſhip keep a good wind,

Many ſhips from conſtruction are liable to make much leeway. This may in a great meaſure be avoided by giving the ſhip a long keel, little breadth, and a conſiderable depth in the hold: whence the bow will meet with little reſiſtance in compariſon to the ſide, and therefore the ſhip will not fall much to the leeward.

18 and to ſail ſmoothly without pitching hard.

Another very great retardation to the velocity of a ſhip is her pitching. The principal remedy for this is to increaſe the length of the keel and floor, to diminiſh the riſing afore and abaft, and to conſtruct the hull in ſuch a manner that the contents of the fore-body may be duly proportioned to the contents of the after-body.

19 Ships of war the lower deck muſt be ſufficiently high above the water.

In a ſhip of war the lower tier of guns ought to be of a ſufficient height above the water, otherwiſe it will be impoſſible to work the lee-guns when it blows hard. This property will be obtained by giving her a long floor-timber, little riſing, a full midſhip frame, light upper works, and the wing tranſom not too high: And in every ſhip the extreme breadth ought always to be higher afore and abaft than at midſhips.

Properties of Ships.

20 Properties of a merchant ſhip, A merchant ſhip, beſides being a faſt ſailer, ought to carry a conſiderable cargo in proportion to its length, to ſail with little ballaſt, and to be navigated with few hands.

21 to take in a great cargo, That a ſhip may take in a conſiderable cargo, it ſhould have a great breadth and depth in proportion to its length, a full bottom, and a long and flat floor. But a ſhip of this conſtruction will neither ſail faſt, nor carry much ſail.

22 and to have ſtability. If a ſhip be filled out much towards the line of floatation, together with low upper works, ſhe will require little ballaſt: and that ſhip which is ſtiff from conſtruction is much better adapted for ſailing faſt than one which, in order to carry the ſame quantity of canvas, is obliged to be loaded with a much greater weight: for the reſiſtance is as the quantity of water to be removed, or nearly as the area of a tranſverſe ſection of the immerſed part of the body at the midſhip frame; and a body that is broad and ſhallow is much ſtiffer than one of the ſame capacity that is narrow and deep.

Principles of Naval Architecture, p. 100.

23 Advantages of a ſhip of a ſmall draught of water, "The advantages (ſays Mr Gordon) are numerous, important, and obvious. For it is evident, that by enlarging, perhaps doubling, the breadth of veſſels, and forming their bottoms flat and well furniſhed with keels, they muſt, in the *firſt* place, become much ſteadier, roll little, if any, and be enabled to carry greatly more ſail, and that in a better direction, at the ſame time that they would be in no danger of being diſmaſted or overſet, unleſs the maſts were of a moſt extraordinary height indeed. *Secondly*, They would have little or no occaſion for ballaſt, and if any was uſed, could incur leſs danger from its ſhifting. *Thirdly*, That there would be much more room upon deck, as well as accommodation below; the breadth being ſo much increaſed without any diminution of the height above the load-water line. *Fourthly*, That they would deviate much leſs from the intended courſe, and penetrate the water much eaſier in the proper direction: for doubling the breadth, without any increaſe of weight, would diminiſh the depth or draught of water one half; and though the extent of the directly oppoſing ſurface would be the ſame as before, yet the veſſel in moving would meet with half the former reſiſtance only; for ſo great is the difference between the preſſure, force, or reaction, of the upper and the under water. *Fifthly*, That they would by this means be adapted for lying unſupported in docks and harbours when dry, be rendered capable of being navigated in ſhallow water, and of being benefited by all the advantages attending that very important circumſtance; and it is particularly to be obſerved, that making veſſels which may be navigated in ſhallow water, may, in many reſpects, juſtly be regarded as a matter of equal importance with increaſing the number of harbours, and improving them, as having identically the ſame effects with regard to navigation; at the ſame time, that the benefits which would reſult from ſuch circumſtances are obtained by this means without either expence, trouble, or inconvenience: beſides, it would not only enable veſſels to enter many rivers, bays, and creeks, formerly inacceſſible to ſhips of burden, but to proceed to ſuch places as are moſt landlocked, where they can lie or ride moſt ſecure, and with leaſt expence of men and ground tackle. As ſhips of war would carry their guns well by being ſo ſteady, there could be but little occaſion for a high topſide, or much height of hull above water; and as little or no ballaſt would be required, there would be no neceſſity, as in other veſſels, for increaſing their weight on that account, and thereby preſſing them deeper into the water. Theſe are very important circumſtances, and would contribute much to improve the ſailing of ſuch veſſels." From whence it appears, that there would be united, what has hitherto been deemed irreconcileable, the greateſt poſſible ſtability, which is nearly as the area of a tranverſe ſection of the immerſed part of the body at the midſhip frame: and a body that is broad and ſhallow is much ſtiffer than one of the ſame capacity that is narrow and deep. A ſhip of this conſtruction may take in a conſiderable cargo in proportion to her ſize; but if deeply loaded will not ſail faſt, for then the area of a ſection of the immerſed part at the midſhip frame will be very conſiderable; and as the ſails of ſuch a ſhip muſt neceſſarily be large, more hands will therefore be required.

The leſs the breadth of a ſhip, the fewer hands will be neceſſary to work her; as in that caſe the quantity of ſail will be leſs, and the anchors alſo of leſs weight. We ſhall gain much (ſays M. Bouguer) by making the extreme breadth no more than the fifth or ſixth part of the length, if, at the ſame time, we diminiſh the depth proportionally; and likewiſe this moſt ſurpriſing circumſtance, that by diminiſhing theſe two dimenſions, or by increaſing the length, a ſhip may be made to go ſometimes as faſt as the wind. 24 and to be navigated with few hands. *Traité du Navire.*

In order to obtain the preceding properties, very oppoſite rules muſt be followed; and hence it appears to be impoſſible to conſtruct a ſhip ſo as to be poſſeſſed of them all. The body, however, muſt be ſo formed, that as many of theſe properties may be retained as poſſible, always obſerving to give the preference to thoſe which are moſt required. If it is known what particular trade the ſhip is to be employed in, thoſe qualities are then principally to be adhered to which are moſt eſſentially neceſſary for that employment. 25 Impoſſible to unite all the qualities in the ſame ſhip.

It may eaſily be demonſtrated that ſmall ſhips will not have the ſame advantages as large ones of a ſimilar form, when employed in the ſame trade: for a large ſhip will not only ſail faſter than a ſmall one of a ſimilar form, but will alſo require fewer hands to work her. Hence, in order that a ſmall ſhip may poſſeſs the ſame advantages as a large one, the correſponding dimenſions will not be proportional to each other. The reader will ſee in Chapman's *Architectura Navalis Mercatoria* ample tables of the ſeveral dimenſions of ſhips, of different claſſes and ſizes, deduced from theory combined with experiment. Tables of the dimenſions of the principal ſhips of the Britiſh navy, and of other ſhips, are contained in the Ship-builder's Repoſitory, and in Murray's Treatiſe on Ship-building. 26 Small ſhips inferior to large ones in point of ſailing, &c.

Chap. II. *Of the different Plans of a Ship.*

When it is propoſed to build a ſhip, the proportional ſize of every part of her is to be laid down; from whence the form and dimenſions of the timbers, and of every particular piece of wood that enters into the conſtruction, is to be found. As a ſhip has length, breadth, and depth, three different plans at leaſt are neceſſary to exhibit

Different Plans of a Ship.

exhibit the form of the ſeveral parts of a ſhip: theſe are are uſually denominated the *ſheer plan*, the *half breadth* and *body plans*.

27 Sheer draught, or elevation.

The *ſheer plan* or *draught*, otherwiſe called the *plan of elevation*, is that ſection of the ſhip which is made by a vertical plane paſſing through the keel. Upon this plan are laid down the length of the keel; the height and rake of the ſtem and ſternpoſt; the ſituation and height of the midſhip and other frames; the place of the maſts and channels; the projection of the head and quarter gallery, and their appendages; and in a ſhip of war the poſition and dimenſions of the gun-ports. Several imaginary lines, namely, the upper and lower height of breadth lines, water lines, &c. are alſo drawn in this plane.

28 Half breadth plan or horizontal plane.

The *half breadth* or, *floor plan*, or, as it is frequently called the *horizontal* plane, contains the ſeveral half-breadths of every frame of timbers at different heights; ribbands, water lines, &c. are alſo deſcribed on this plane.

29 Body plan, or projection.

The *body* plan, or *plane of projection*, is a ſection of the ſhip at the midſhip frame or broadeſt place, perpendicular to the two former. The ſeveral breadths, and the particular form of every frame of timbers, are deſcribed on this plane. As the two ſides of a ſhip are ſimilar to each other, it is therefore unneceſſary to lay down both; hence the frames contained between the main frame and the ſtem are deſcribed on one ſide of the middle line, commonly on the right hand ſide, and the after frames are deſcribed on the other ſide of that line.

30 The various lines laid down on theſe plans.

Several lines are deſcribed on theſe planes, in order the more readily to aſſiſt in the formation of the timbers; the principal of which are the following:

The *top-timber line*, is a curve limiting the height of the ſhip at each timber.

The *top-timber half breadth line*, is a ſection of the ſhip at the height of the top-timber line, perpendicular to the plane of elevation.

The *height of breadth lines*, are two lines named the *upper* and *lower* heights of breadth. Theſe lines are deſcribed on the plane of elevation to determine the height of the broadeſt part of the ſhip at each timber; and being deſcribed in the body plan, limit the height and breadth of each frame at its broadeſt part.

Main half breadth, is a ſection of the ſhip at the broadeſt part, perpendicular to the ſheer plan, and repreſents the greateſt breadth at the outſide of every timber.

Water lines, are lines ſuppoſed to be deſcribed on the bottom of a ſhip when afloat by the ſurface of water; and the uppermoſt of theſe lines, or that deſcribed by the water on the ſhip's bottom when ſufficiently loaded, is called the *load water line*. According as the ſhip is lightened, ſhe will riſe higher out of the water; and hence new water lines will be formed. If ſhe be lightened in ſuch a manner that the keel may preſerve the ſame inclination to the ſurface of the water, theſe lines will be parallel to each other; and if they are parallel to the keel, they will be repreſented by ſtraight lines parallel to each other in the body plan; otherwiſe by curves. In the half breadth plan, theſe lines are curves limiting the half breadth of the ſhip at the height of the correſponding lines in the ſheer plan. In order to diſtinguiſh theſe lines, they are uſually drawn in green.

Ribband lines, are curves on a ſhip's bottom by the interſection of a plane inclined to the plane of elevation; and are denominated *diagonal* or *horizontal*, according as they are meaſured upon the diagonal, or in a direction perpendicular to the plane of elevation. Both theſe anſwer to the ſame curve on the ſhip's bottom, but give very different curves when deſcribed on the half breadth plan.

31 Frames, compoſed of a floor timber, futtocks, and top timber.

Frames, are circular pieces of timber bolted together, and raiſed upon the keel at certain diſtances, and to which the planks are faſtened. A frame is compoſed of one floor-timber, two or three futtocks, and a top-timber on each ſide: which being united together, form a circular incloſure, and that which incloſes the greateſt ſpace is called the *midſhip* or *main* frame. The arms of the floor-timber of this frame form a very obtuſe angle; but in the other frames this angle decreaſes with the diſtance of the frame from midſhips. Thoſe floor-timbers which form very acute angles are called *crutches*. The length of the midſhip floor-timber is in general about half the length of the main frame.

Sweeps of the ſeveral parts of a frame.

A frame of timbers is commonly formed by arches of circles called *ſweeps*. There are generally five ſweeps: 1ſt, The *floor ſweep*; which is limited by a line in the body plan perpendicular to the plane of elevation, a little above the keel; and the height of this line above the keel at the midſhip frame is called the *dead riſing*. The upper part of this arch forms the head of the floor timber. 2d, The *lower breadth ſweep*; the centre of which is in the line repreſenting the lower height of breadth. 3d, The *reconciling ſweep*. This ſweep joins the two former, without interſecting either; and makes a fair curve from the lower height of breadth to the riſing line. If a ſtraight line is drawn from the upper edge of the keel to touch the back of the floor ſweep, the form of the midſhip frame below the lower height of breadth will be obtained. 4th, The *upper breadth ſweep*; the centre of which is in the line repreſenting the upper height of breadth of the timber. This ſweep deſcribed upwards forms the lower part of the top timber. 5th, The *top timber ſweep* is that which forms the hollow of the top timber. This hollow is, however, very often formed by a mould, ſo placed as to touch the upper breadth ſweep, and paſs through the point limiting the half breadth of the top timber.

32 Names of frames.

The main frame, or as it is uſually called *dead-flat*, is denoted by the character ⊕. The timbers before dead-flat are marked A, B, C, &c. in order; and thoſe abaft dead-flat by the figures 1, 2, 3, &c. The timbers adjacent to dead-flat, and of the ſame dimenſions nearly, are diſtinguiſhed by the characters (A), (B), &c. and (1), (2), &c. That part of the ſhip abaft the main frame is called the *after body*; and that before it the *fore body*.

All timbers are perpendicular to the half breadth plan. Thoſe timbers whoſe planes are perpendicular to the ſheer plan, are called *ſquare timbers*; and thoſe whoſe planes are inclined to it are called *canted timbers*.

The *riſing line*, is a curve drawn in the ſheer plan, at the heights of the centres of the floor ſweeps in the body plan. As, however, this line, if drawn in this manner, would extend beyond the upper line of the figure, it is therefore uſually ſo drawn that its lower part may touch the upper edge of the keel. This is performed by taking the heights of each of the centres in the

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the body plan, from the height of the centre of the sweep of dead-flat, and setting them off on the corresponding timbers in the sheer plan from the upper edge of the keel.

Half breadth of the rising, is a curve in the floor plan, which limits the distances of the centres of the floor sweeps from the middle line of the body plan.

The rising of the floor, is a curve drawn in the sheer plan, at the height of the ends of the floor timbers. It is limited at the main frame or dead flat by the dead rising, and in flat ships is nearly parallel to the keel for some timbers afore and abaft the midship frame; for which reason these timbers are called *flats*: but in sharp ships it rises gradually from the main frame, and ends on the stem and post.

Cutting-down line, is a curve drawn on the plane of elevation. It limits the depth of every floor timber at the middle line, and also the height of the upper part of the dead wood afore and abaft.

Timber and room, or *room and space*, is the distance between the moulding edges of two timbers, which must always contain the breadth of two timbers and an interval of about two or three inches between them. In forming the timbers, one mould serves for two, the foreside of the one being supposed to unite with the aftside of the other, and so make only one line, which is called the *joint of the timbers*.

34 Principal pieces that compose a ship. Plate cccclxxxiv. Fig. 1.

In order to illustrate the above, and to explain more particularly the principal pieces that compose a ship, it will be necessary to give a description of them. These pieces are for the most part represented according to the order of their disposition in fig. 1.

A, Represents the pieces of the keel to be securely bolted together and clinched.

B, the sternpost, which is tenanted into the keel, and connected to it by the knee G.

E, The back of the post, which is also tenanted into the keel, and securely bolted to the post; the intention of it is to give sufficient breadth to the port, which seldom can be got broad enough in one piece. C is the false post, which is fayed (B) to the fore part of the sternpost.

C, The stem, in two pieces, to be scarfed together. The stem is joined to the fore foot, which makes a part of both.

H, The apron, in two pieces, to be scarfed together, and fayed on the inside of the stem, to support the scarf thereof; and therefore the scarf of the apron must be at some distance from that of the stem.

I, The stemson, in two pieces, to support the scarf of the apron.

D, The beams which support the decks; and F the knees by which the beams are fastened to the sides of the ship.

K, The wing transom: it is fayed across the sternpost, and bolted to the head of it, and its extremities are fastened to the fashion pieces. L, Is the deck transom, parallel to the wing transom. M, N, Two of the lower transoms: these are fastened to the sternpost and fashion pieces in the same manner as the wing transom. Q, The knee which fastens the transom to the ship's side. And, O, The fashion piece, of which there is one on each side. The keel of the fashion piece is connected with the dead-wood, and the head is fastened to the wing transom.

Different Plans of a Ship.

R, S, Breast-hooks: these are fayed in the inside to the stem, and to the bow on each side of it, to which they are fastened with proper bolts. There are generally four or five in the hold, in the form of that marked R, and one in the form of that marked S, into which the lower deck planks are rabbeted: There is also one immediately under the hause holes, and another under the second deck.

T, The rudder, which is joined to the sternpost by the rudder irons, upon which it turns round in the googings, fastened to the sternpost for that purpose. There is a mortise cut in the head of the rudder, into which a long bar is fitted called the *tiller*, and by which the rudder is turned.

U, A floor timber: it is laid across the keel, to which it is fasten-d by a bolt through the middle. V, V, V, V, The lower, the second, third, and fourth futtocks. W, W, The top timbers. These represent the length and scarf of the several timbers in the midship frame.

X, The pieces which compose the kelson. They are scarfed together in the same manner as the keel, and placed over the middle of the floor timbers, being scored about an inch and a half down upon each side of them, as represented in the figure.

Y, The several pieces of the knee of the head; the lower part of which is saved to the stem, and its keel is scarfed to the head of the forefoot. It is fastened to the bow by two knees, called *cheeks*, in the form of that represented by Z; and to the stem, by a knee called a *standard*, in the form of that marked ⊕.

a, The cathead, of which there is one on each side of the bow, projecting so far as to keep the anchor clear of the ship when it is hove up.

b, The bits, to which the cable is fastened when the ship is at anchor.

d, The side counter-timbers, which terminate the ship abaft within the quarter gallery.

e, *e*, Two pieces of dead wood, one afore and the other abaft, fayed on the keel.

Fig. 2. is a perspective representation of a ship framed and ready for the planking; in which A, A is the keel; B, the sternpost; C, the stem; K, L, M, the transoms; F, F, F, F, F, F, the ribbands. Fig. 2.

CHAP. III. *Containing Preliminary Problems*, &c.

The general dimensions of a ship are the *length*, *breadth*, and *depth*.

35 Proportional dimensions of a ship 36 to be inferred from theory combined with practice;

To ascertain those dimensions that will best answer the intended purpose is, no doubt, a problem of considerable difficulty; and, from theory, it may be shown that there are no determinate proportions subsisting between the length, breadth, and depth, by which these dimensions may be settled; yet, by combining theory and practice, the proportional dimensions may be approximated to pretty nearly.

As

(B) To *fay*, is to join two pieces of timber close together.

Preliminary Problems. As ships are constructed for a variety of different purposes, their principal dimensions must therefore be altered accordingly, in order to adapt them as nearly as possible to the proposed intention; but since there is no fixed standard whereby to regulate these dimensions, the methods therefore introduced are numerous, and in a great measure depend upon custom and fancy.

37 and also from the circle. With regard, however, to the proportional dimensions, they perhaps may be inferred from the circle. Thus, if the extreme breadth be made equal to the diameter, the length at the load water line, or the distance between the rabbets of the stem and post at that place, may be made equal to the circumference of the same circle; and the depth of the hold equal to the radius, the upper works being continued upwards according to circumstances. A ship formed from these dimensions, with a bottom more or less full according as may be judged necessary, will no doubt answer the proposed intention. Nevertheless, one or other of these dimensions may be varied in order to gain some essential property, which the trade that the vessel is intended for may require.

* *Practical Seamanship*, page 25.

The following hints are given by Mr Hutchinson * towards fixing rules for the best construction of ships bottoms.

† See Book ii. chap. 2.

1. "I would recommend (says he), to prevent ships bottoms from hogging † upwards amidship, to have the fore and after part of their keels deep enough, that the upper part may be made to admit a rabbet for the garboard streak, that the main body and bearing part of the ships bottoms may be made to form an arch downwards in their length, suppose with the same sheer as their bends, at the rate of about 2 inches for every 30 feet of the extreme length of the keel towards the midship or main frame, which may be reckoned the crown of the arch; and the lower part of the keel to be made straight, but laid upon blocks so that it may form a regular convex curve downwards at the rate of an inch for every 30 feet of the extreme length of the keel, the lowest part exactly under the main frame; which curve, I reckon, is only a sufficient allowance for the keel to become straight below, after they are launched afloat, by the pressure of the water upward against their floors amidship, which causes their tendency to hog. And certainly a straight keel is a great advantage in sailing, as well as to support them when laid upon level ground or on straight blocks in a repairing dock, without taking damage.

2. "As square sterned ships, from experience, are found to answer all trades and purposes better than round or pink sterned ships, I would recommend the fore part of the sternpost, on account of drawing the water lines in the draught, only to have a few inches rake, that the after part may stand quite upright perpendicular to the keel: and for the rake of the stem I would propose the rabbet for the hudding ends for the entrance, and bows from the keel upwards, to form the same curve as the water line from the stem at the harpin towards the main breadth, and the bows at the harpin to be formed by a sweep of a circle of half the three-fourths of the main breadth; and the main transom to be three-fourths of the main-breadth; and the buttocks, at the load or sailing mark aft, to be formed, in the same manner as the bows at the harpin, with a sweep of a circle of half the three fourths of the main breadth, to extend just as far from the stem and stern post as to admit a regular convex curve to the main frame, and from these down to the keel to form regular convex water-lines, without any of those unnatural, hollow, concave ones, either in the entrance or run; which rules, in my opinion, will agree with the main body of the ship, whether she is designed to be built full for burden or sharp below for sailing. [illegible] Problems.

3. "This rule for raking the stem will admit all the water-lines in the ship's entrance to form convex curves all the way from the stem to the midship or main frame, which answers much better for sailing as well as making a ship more easy and lively in bad weather. And the bows should flange off, rounding in a circular form from the bends up to the gunwale, in order to meet the main breadth the sooner, with a sweep of half the main breadth at the gunwale amidships; which will not only prevent them greatly from being plunged under water in bad weather, but spread the standing fore-rigging the more, to support these material masts and sails forward to much greater advantage than in those over sharp bowed ships, as has been mentioned. And as the sailing trim of ships in general is more or less by the stern, this makes the water lines of the entrance in proportion the sharper to divide the particles of water the easier, so that the ship may press through it with the least resistance.

4. "The run ought to be formed shorter or longer, fuller or sharper, in proportion to the entrance and main body, as the ship is designed for burden or sailing fast. The convex curves of the water lines should lessen gradually from the load or sailing mark aft, as has been mentioned, downwards, till a fair straight taper is formed from the after part of the floor to the sternpost below, without any concavity in the water lines; which will not only add buoyancy and burden to the after body and run of the ship, but, in my opinion, will help both her sailing and steering motions; for the pressure of the water, as it closes and rises upon it to come to its level again, and fill up that hollow which is made by the fore and main body being pressed forward with sail, will impinge, and act with more power to help the ship forward in her progressive motion, than upon those unnatural concave runs, which have so much more flat dead wood, that must, in proportion, be a hinderance to the stern being turned so easily by the power of the helm to steer the ship to the greatest advantage."

Many and various are the methods which are employed to describe the several parts of a ship. In the following problems, however, those methods only are given which appear to be most easily applied to practice, and which, at the same time, will answer any proposed purpose.

Problem I. To describe in the plane of elevation the sheer or curvature of the top timbers.

Let QR (fig 3.) be the length of the ship between the wing transom and the rabbet of the stem. Then since it is generally agreed, especially by the French constructors, that the broadest part of the ship ought to be about one-twelfth of the length before the main frame or dead flat; therefore make R$\oplus$ equal to five-twelfths of QR, and $\oplus$ will be the station of the main frame; space the other frames on the keel, and from these points let perpendiculars be drawn to the keel. Let $\oplus$P be the height of the ship at the main frame, Plate cccclxxxv. Fig. 3. 38 The place of the main frame about one-twelfth before the [illegible] of the ship.

VF

Preliminary Problems.

VF the height at the aftermoſt frame, and RK the height at the ſtem. Through P draw EPL parallel to the keel; deſcribe the quadrants PGI, PMN, the radius being P⊕; make PH equal to EF, and PO equal KL, and draw the parallels GH, OM: Divide GH ſimilar to ⊕C, and OM ſimilar to ⊕R. Through theſe points of diviſion draw lines perpendicular to EL, and the ſeveral portions of theſe perpendiculars contained between EL and the arch will be the riſings of the top-timber line above EL. A curve drawn through theſe points will form the top-timber line.

39 Method of deſcribing the top-timber line.

This line is more eaſily drawn by means of a curved or bent ruler, ſo placed that it may touch the three points F, P, and K.

40 The ſtem, Fig 3.

PROB. II. To deſcribe the ſtem.

Let K (fig. 3.) be the upper part of the ſtem, through which draw KS parallel to the keel, and equal to twice KR: Through the termination of the wales on the ſtem draw TW parallel to QR. Then from the centre S, with the diſtance SK, deſcribe an arch: Take an extent equal to the neareſt diſtance between the parallels WT, QR; and find the point W, ſuch that one point of the compaſs being placed there, the other point will juſt touch the neareſt part of the above arch; and from this point as a centre deſcribe an arch until it meets the keel, and the ſtem will be formed.

41 and poſt. Fig. 3.

PROB. III. To deſcribe the ſternpoſt.

Set off QV (fig. 3.) for the rake of the poſt: draw VX perpendicular to the keel, and equal to the height of the wing tranſom, join QX, and it will repreſent the aft ſide of the poſt.

42 Main half breadth line. Fig. 4.

PROB. IV. To deſcribe the half breadth line.

Let MN (fig. 4.) be the given length: Make N⊕ equal to five-twelfths of MN; draw the line ⊕P perpendicular to MN, and equal to the propoſed extreme half breadth. Let ME be the round aft of the ſtern or wing tranſom; make EO perpendicular to MN, and equal to the given half breadth at the ſtern, which is generally between two-thirds and three-fourths of the main half breadth; and deſcribe the arch MO, the centre of which is in the middle line. Space the frames (A), A, B, &c. and (1), 1, 2, &c. From the centre ⊕, with the radius ⊕P, deſcribe the quadrant PRS; deſcribe alſo the quadrant PCT. Through the point O draw ORU parallel to MN; divide the ſtraight line RU ſimilar to M⊕; and through theſe points of diviſion draw lines perpendicular to MN, and meeting the arch. Transfer theſe lines to the correſpondent frames each to each, and a curve drawn through the extremities will repreſent that part of the ſide contained between the main frame and the ſtern. Again, through Q, the extremity of the foremoſt frame, draw QV parallel to MN. Or make PV a fourth or third part of PU, according as it is intended to make the ſhip more or leſs full towards the bow. Divide VC ſimilar to ⊕C; through theſe points draw lines perpendicular to MN, and terminating in the quadrantal arch: Transfer theſe lines to the correſponding timbers in the fore part, and a curve drawn through the extreme points will limit that part of the ſhip's ſide contained between P and Q. Continue the curve to the next timber at X. From Q draw QZ perpendicular to QX; make the angle ZNQ equal to ZQN, and the point Z will be the centre of the arch forming the bow. Remark, if it is propoſed that the breadth of the ſhip at the frames adjacent to the main frame ſhall be equal to the breadth at the main frame; in this caſe, the centres of the quadrantal arches will be at the points of interſection of theſe frames with the line MN; namely, at (A) and (1). Alſo, if the height of the ſhip at the frames (A) and (1) is to be the ſame as at dead flat, the quadrantal arches in fig. 3. are to be deſcribed from the points of interſection of theſe frames with the line EL.

These rules, it is evident, are variable at pleaſure; and any perſon acquainted with the firſt principles of mathematics may apply calculation to find the radii of the ſeveral ſweeps.

PROB. V. To deſcribe the main frame or dead flat. 43

This frame is that which contains the greateſt ſpace, and the particular form of each of the other frames depends very much on it. If the ſhip is intended to carry a great burden in proportion to her principal dimenſions, this frame is made very full; but if ſhe is intended to ſail faſt, it is uſually made ſharp. Hence ariſes diverſity of opinions reſpecting its form; each conſtructor uſing that which to him appears preferable. In order to ſave repetition, it is judged proper to explain certain operations which neceſſarily enter into all the different methods of conſtructing this frame.

Of the midſhip frame.

In the plane of the upper ſide of the keel produced, draw the line AB (fig. 5.) equal to the propoſed breadth of the ſhip; biſect AB in C, and draw AD, CE, and BF, perpendicular to AB. Then, ſince the two ſides of a ſhip are ſimilar, it is therefore thought ſufficient to deſcribe the half of each frame between the main frame and the ſtern on one ſide of the middle line CE, and the half of each of thoſe before the main frame on the other ſide of it. The firſt half is called the *after-body*, and the other the *fore-body*. The after-body is commonly deſcribed on the left ſide of the middle line; and the fore-body on the right ſide of it: hence the line AD is called the *ſide line* of the *after* body, and BF the ſide line of the *fore* body. Make AD and BF each equal to the height of the ſhip at the main frame. Make AG, BG, and AH, BH, equal to the lower and upper heights of breadth reſpectively, taken from the ſheer plan. Let II be the load water line, or line of floatation when the ſhip is loaded, and KK the height of the riſing line of the floor at this frame. Make CN, CO, each equal to half the length of the floor timber, and N, O, will be the heads of the floor timber, through which draw perpendiculars to AB. Make C*m*, E*m*, each equal to half the thickneſs of the ſternpoſt, and C*n*, E*n*, equal to half the thickneſs of the ſtem, and join *mm*, *nn*.

44 General precepts for deſcribing Fig. 5.

Method I. *Of deſcribing a main frame.*—From the centre *a* (fig. 5.), in the lower breadth line, deſcribe the lower breadth ſweep G*e*; make N*b* equal to the propoſed radius of the floor ſweep, and from the centre *b* deſcribe the floor ſweep N*f*. Let the radius of the reconciling ſweep be A*g*, equal to about the half of AC; then make A*h* equal to N*b*, and A*m* equal to G*a*. Now from the centre *a*, with an extent equal to *gm*, deſcribe an arch, and from the centre *b*, with the extent *gh*, deſcribe an arch interſecting the former in *c*, which will be the centre of the reconciling ſweep *ef*. Join N*m* by an inverted curve, the centre of which may be in the line *b*N produced downwards; or it may be joined

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joined by two curves, or by a straight line if there is little rising; and hence the lower part of the main frame will be described.

In order to form the top timber, make F k equal to such part of the half breadth, agreeable to the proposed round of the side, as one-seventh; join H k, and make $k\,i$ equal to about two-thirds of H k: make the angle H i l equal to i H l; and from the centre l at the distance l H describe the arch H i; and from the centre o, the intersection of $l\,i$, and k F produced, describe the arch $i\,k$, and the top timber will be formed.

II. *To describe a main frame of an intermediate capacity, that is, neither too flat nor too sharp.*—Divide the line AX (fig. 6.), which limits the head of the floor timber, into three equal parts; and make $a\,b$ equal to one of them. Divide the line d B, the perpendicular distance between the load water line and the plane of the upper side of the keel, into seven equal parts; and set off one of these parts from d to c, and from c to m. Let GH be the lower deck, join G m, and produce it to q. Draw the straight line V a, bisect it in n, and from the points n, a, describe arches with the radius Gq intersecting each other in P, which will be the centre of the arch $n\,a$. The centre of the arch V n is found by describing arches downwards with the same radius.

Fig. 6.

With an extent equal to once and a half of B e, describe arches from the points b, e, intersecting each other in A, and from this point as a centre describe the arch $e\,b$; make $a\,l$ equal to $d\,m$, and join A m, A l. Then, in order to reconcile two arches so as to make a fair curve, the centres of these arches and of the points of contact must be in the same straight line. Hence the point k will be the centre of the arch $d\,m$, and o the centre of the arch $a\,l$. The arch $l\,m$ is described from the centre A.

To form the top timber, set back the tenth part of the half breadth from K to S upon the line of the second deck; then with an extent equal to two-thirds of the whole breadth describe an arch through the points S and H, the upper height of breadth. Again, make MI equal to the fifth part of the half breadth; describe an arch of a circle through the points S and T, taking the diagonal GB for the radius. As this arch is inverted in respect of the arch d S, the centre will be without the figure. Hence one-half of the main frame is formed, and the other half is described by similar operations.

Remark. This frame may be made more or less full by altering the several radii.

III. *To describe a main frame of a circular form.*—Let the several lines be drawn as before: Then make O a (fig. 7.) equal to the half breadth G a, and from the centre a, with the radius G a, describe the arch b G c O. Let d be the head of the floor-timber, and $d\,x$ the rising. Assume the point f in the arch, according to the proposed round of the second futtock, and describe the arch $d\,f$; the centre of which may be found as in the former method: from the centre a, with the distance $a\,d$, describe the arch $d\,c$ O; make $d\,c$ equal to one-third of d O, and the angle $d\,c\,h$ equal to $c\,d\,h$, and from the centre h describe the arch $d\,c$. The inverted arch c O may be described as before.

Plate cccclxxxvi. Fig. 7.

IV. *To describe a very full main frame.*—Let the vertical and horizontal lines be drawn as before: let b, fig. 8. be the floor-head, and $b\,x$ the rising. Divide G c into two equal parts in the point d, and upon $c\,d$ describe the square $d\,b\;a\,c$, in which inscribe the quadrant $d\,e\,a$. Divide the line $b\,d$ into any number of equal parts in the points O, N, M, L, and draw the lines L m, M e, N n, O b, perpendicular to $d\,b$. Divide the line G C, the depth of the hold, the rising being deducted, into the same number of equal parts in the points E, F, I, K, and make the lines E p, F q, I r, K s, in the frame, equal to the lines O b, N n, M e, L m, in the square, each to each respectively; and through the points G, p, q, r, s, b, describe a curve. The remaining part of the frame may be described by the preceding methods.

Fig. 8.

V. *To describe the main frame of a ship intended to be a fast sailer.*—The principal lines being drawn as before, let the length of the floor-timber be equal to half the breadth of the ship, and the rising one-fifth or one-sixth of the whole length of the floor-timber, which lay off from x to E, fig. 9. Through the point E draw the line T x perpendicular to GC, and d E perpendicular to AG. Join T d, which bisect in B, and draw BF perpendicular thereto, and meeting CG produced in F, from the centre F, at the distance FT, describe the semicircle T dD. Divide GT into any number of parts, VW, &c. and bisect the intervals DV, DW, &c. in the points X, Z, &c.; then, from the centre X, with the extent XV, describe the semicircle D b V, intersecting AG in b. Let VP be drawn perpendicular to GT, and b P perpendicular to AG, and the point of intersection P will be one point through which the curve is to pass. In like manner proceed for the others, and a curve drawn through all the points of intersection will be part of the curve of the main frame. The remaining part of the curve from E to Y will be composed of two arches, the one to reconcile with the former part of the curve at E, and the other to pass through the point Y, the centre of which may be found by any of the preceding methods. In order to find the centre of that which joins with the curve at E, make TR equal to the half of GD, and join ER, in which a proper centre for this arch may be easily found.

Fig. 9.

The portion G b E of the curve is a parabola, whose vertex is G and parameter GD.

For GD : G b : : G b : GV by construction.

Hence DG $\times$ GV $=$ Gb^2, which is the equation for a parabola.

VI. *To describe a main frame of a middling capacity.*—Let the length of the floor-timber be equal to one-half of the breadth of the ship. Make O d, fig. 10. equal to one-fourth of the length of the floor-timber, and draw the perpendicular $d\,c$ equal to the rising, and divide it into two equal parts in the point e. Describe an arch through e, and the extremity a of the floor-timber, the radius being equal to the half breadth, or more or less according to the proposed round of the floor-head. Then with the radius O l, half the length of the floor-timber, describe the arch e Y.

Fig. 10.

Draw $l\,m$ perpendicular to OA: bisect A n in p, and draw the perpendicular $p\,q$. From the middle of A p draw the perpendicular $r\,s$, and from the middle of A r draw the perpendicular $t\,u$. Make $n\,z$, $p\,g$, each equal to $l\,n$: make the distances $p\,y$, $r\,b$, each equal to $a\,g$: r F, t E, each equal to $a\,b$; and $t\,x$ equal to a E. Then a curve drawn through the points a, z, y, F, x, T, will form the under part of the midship frame.

We shall finish these methods of describing the main frame

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frame of a fhip with the following remark from M. Vial du Clairbois *. "It feems (fays he) that they have affected to avoid ftraight lines in naval architecture; yet, geometrically fpeaking, it appears that a main frame formed of ftraight lines will have both the advantage and fimplicity over others." To illuftrate this, draw the ftraight line MN (fig. 9.) in fuch a manner that the mixtilineal fpace M a d may be equal to the mixtilineal fpace DNY. Hence the capacity of the main frame formed by the ftraight lines MN, NY will be equal to that of the frame formed by the curve M a DY; and the frame formed by the ftraight lines will for the moft part be always more fufceptible of receiving a bow that will eafily divide the fluid. It is alfo evident, that the cargo or ballaft, being lower in the frame formed of ftraight lines than in the other, it will therefore be more advantageoufly placed, and will enable the fhip to carry more fail (C); fo that having a bow equally well or better formed, fhe will fail fafter.

* Architecture Navale, p. 22.

Traité de Navire de Bouguer, p. 601.

PROB. VI. To defcribe a ftern having a fquare tuck.

Fig. 11.

Let AB (fig. 11.) be the middle line of the poft, and let CD be drawn parallel thereto at a diftance equal to half the thicknefs of the poft. Make CE equal to the height of the lower part of the fafhion-piece above the keel: make CT equal to the height of the extremity G of the tranfom above the plane of the keel produced, and CH equal to the height of the tranfom on the poft, HT being equal to above one-ninth or one-tenth of GT, and defcribe the arch GH, the centre of which will be in BA produced: make EK equal to five-twelfths of ET: through K draw KL perpendicular to CD, and equal to EK; and with an extent equal to EL defcribe the arch EL. Make GI equal to the half of ET, and from the centre I defcribe the arch GM, and draw the reconciling curve ML.—Let the curve of the fafhion-piece be produced upwards to the point reprefenting the upper height of breadth as at O. Make ON equal to the height of the top-timber, and BN equal to the half breadth at that place, and join ON. Through N and the upper part of the counter, let arches be defcribed parallel to GH. The tafferel, windows, and remaining part of the ftern, may be finifhed agreeable to the fancy of the artift.

Fig. 12.

In fig. 12. the projection of the ftern on the plane of elevation is laid down, the method of doing which is obvious from infpection.

Plate cccclxxxvii. Fig. 14.

If the tranfom is to round aft, then fince the fafhion-pieces are always fided ftraight, their planes will interfect the fheer and floor planes in a ftraight line. Let Gg (fig. 14.) be the interfection of the plane of the fafhion-piece with the floor plane. From the point g draw gW perpendicular to gM: make yk equal to the height of the tuck, and Wk being joined will be the interfection of the plane of the fafhion-piece with the fheer plane. Let the water lines in the fheer plane produced meet the line kW in the points a, s, h, and draw the perpendiculars aa, fs, hh. From the points a, s, h (fig. 14.) draw lines parallel to Gg to interfect each correfponding water line in the floor plane in the points 3, 2, 1. From the points G, 3, 2, 1, in the floor-plane draw lines perpendicular to gM, interfecting the water lines (fig. 13.) in the points G, 3, 2, 1; and through thefe points defcribe the curve G 3 2 1 k; and WG 3 2, 1 k will be the projection of the plane of the fafhion-piece on the fheer plane. Through the points G, 3, 2, 1 (fig. 13.) draw the lines GF, 3 A, 2 S, 1 H, perpendicular to Wk; and make the lines WF, aA, sS, hH, equal to the lines gG, a 3, s 2, h 1 (fig. 14.) refpectively, and WFASHk will be the true form of the plane of the aft fide of the fafhion-piece. When it is in its proper pofition, the line WF will be in the fame plane with the fheer line; the line aA in the fame plane with the water line a 3; the line sS in the fame plane with the water line s 2; and the line hH in the fame plane with the water line h 1. If lines be drawn from the feveral points of interfection of the water lines with the rabbet of the port (fig. 13.), perpendicular to gM, and curved lines being drawn from thefe points to G, 3, 2, 1 (fig. 14.) refpectively, will give the form and dimenfions of the tuck at the feveral water lines. Fig. 13. Fig. 14.

PROB. VII. To bevel the fafhion-piece of a fquare tuck by water-lines.

As the fafhion-piece both rakes and cants, the planes of the water-lines will therefore interfect it higher on the aft than on the fore-fide: but before the heights on the fore-fide can be found, the breadth of the timber muft be determined; which let be bn (fig. 15.). Then, as it cants, the breadth in the direction of the water-line will exceed the true breadth. In order to find the true breadth, form the aft-fide of the fafhion-piece as directed in the laft problem.

Let t 5 (fig. 13.) be the aft-fide of the rabbet on the outfide of the poft, WM the common fection of the plan of the fafhion-piece and the fheer-plan. Before this laft line can be determined, the feveral water-lines 1, 2, 3, 4, and 5, muft be drawn parallel to the keel, which may reprefent fo many tranfoms.—Let thefe water-lines be formed and ended at the aft-fide of the rabbet, as in fig. 14. where the rounds aft of the feveral tranfoms are defcribed, limiting the curves of the water-lines. Now the line WM muft rake fo as to leave room for half the thicknefs of the poft, at the tuck: in order to which, produce Wg to r; make rg half the thicknefs of the poft; through r draw a line parallel to gM to interfect gG in b: then with the radius rb, from x the point of the tuck as a centre, defcribe an arch, and draw the line WM juft to touch the back of that arch. Fig. 15.

The line WM being drawn, let any point k in it be affumed at pleafure: from k draw ky perpendicular to gM: through y draw yf (fig. 14.) parallel to gG, interfecting the line Mf drawn perpendicular to gM in the point f. From M draw Mi perpendicular to yf, and from y draw yn perpendicular to WM (fig. 13.). Make Mn (fig. 15.) equal to Mi (fig. 14.); then MI (fig. 15.) being equal to yk (fig. 13.), join n I, and the angle I nM will be the bevelling to the horizontal plane. Again, make Mz, Mf (fig. 15.) refpectively equal to yn (fig. 13.) and Mf (fig. 14.), and join zf; and

(C) It is not a general rule, that lowering the cargo of a fhip augments her ftability. This is demonftrated by the Chevalier de Borda, in a work publifhed by M. de Goimpy upon this fubject. See alfo *L'Architecture Navale par M. Vial du Clairbois*, p. 23.

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and the angle M $z f$ will be the bevelling to the sheer-plane.

Fig. 15.

The bevelling being now found, draw the line $a b$ (fig. 15.) parallel to $z n$, $a z$ or $b n$ being the scantling of the timber. Then $n x$ will be the breadth of the timber on the horizontal plane, and $z e$ its breadth on the sheer-plane, and $a c$ what it is within a square.

Now as the lines g G, a 3, s 2, h 1, y i, represent the aft-side of the fashion-piece on the horizontal plane (fig. 14.), dotted lines may be drawn parallel to them to represent the fore-side, making $n x$ (fig. 15.) the perpendicular distance between the lines representing fore and aft sides of the fashion-piece. By these lines form the fore-side of the fashion-piece in the same manner as the aft-side was formed. The water-lines on the fore-side of the plane of the fashion-piece must, however, be first drawn in fig. 13. thus: Draw the lines $e b$, $c d$ parallel to WM, and whose perpendicular distances therefrom may be equal to $a c$ and $z e$ (fig. 15.) respectively. Draw a line parallel to a A through the point where the line $c d$ intersects the fifth water-line. Draw a line parallel to a A through the point where the fourth water-line intersects the line $c d$; in like manner proceed with the other water-lines. The fore-side of the fashion-piece is now to be described by means of these new water-lines, observing that the distances in the floor-plane must be set off from the line $e b$, and not from WM, as in the former case; and a curve described through the points 5, 3, 2, 1, where these distances reach to, will represent the fore-side of the fashion-piece.

The nearest distance between the points 5, 3, 2, 1 and the aft side of the fashion-piece is what the bevelling is beyond the square when both stock and tongue of the bevel are perpendicular to the timber. Make Mp

Fig. 16.

(fig. 16.) equal to the breadth of the timber, and M 5 equal to the perpendicular distance of the point 5 (fig. 13.) from the aft-side of the fashion-piece, and join 5 p. In like manner proceed with the others, and the bevellings at these parts will be obtained; but, in order to avoid confusion, the perpendiculars 4, 3, 2, (fig. 13.), instead of being laid off from M (fig. 16.), were set off from points as far below M as the other extremities of the lines drawn from these points are below the point p.

PROB. VIII. To describe the transoms of a round poop.

The transoms are fastened to the stern-post in the same manner that the floor-timbers are fastened to the keel, and have a rising called the *flight* similar to the rising of the floor-timbers. The upper transom is called the *wing* transom, the next the *deck* transom, and the others the *first*, *second*, and *third* transoms in order. The wing transom has a round aft and a round up: the round up of the deck transom is the same as that of the beams.

The fashion-piece of a square tuck must be first described, together with the three adjacent frames, by the method to be explained. The part of the stern above the wing transom is to be described in the same manner as before, and may therefore be omitted in this place. The part below the keel of the fashion-piece is also the

Plate cccclxxxviii Fig. 17.

same in both cases. Let fig. 17. represent the fashion-piece of a square tuck, and the three adjoining frames. Divide the interval AB into four equal parts in the points C, D, E, and draw the perpendiculars AF, CG, DH, EI, and BK: these will be portions of water-lines answering to the several transoms.

Fig. 18.

Let these water-lines be described on the floor-plan (fig. 18.), in which ABC represents the wing transom. Describe the arch bC to reconcile the curves A b and CE. Let LFG be the water-line answering to the lower part of the fashion-piece, the distance between the points L and A being equal to the excess of the projection of the point A beyond that of B (fig. 20.). Draw CK (fig. 18.) perpendicular to AM, and make the angle KCM equal to about 25 degrees, and CN will be the projection of the fashion-piece on the floor-plane. Make AB (fig. 19.) equal to AB

Fig. 19.

(fig. 17.). Divide it into four equal parts, and draw the perpendiculars AF, CH, DI, EK, and BG. Make AF equal to CM, and BG equal to MN, and draw the curve FHIKG, having a less curvature than the fashion-piece of the square tuck $s c p g n$. Make MO, MP, MQ, equal to CH, DI, and EK respectively. Divide AL (fig. 18.) into four equal parts, and to these points of division draw curves through the points O, P, Q, so as to partake partly of the curvature of A b CE and partly of that of LNF, but most of the curvature of that to which the proposed curve is nearest; and hence the form of the several transoms will be obtained.

In order to represent the curve of the fashion-piece on the plane of projection, make the lines AF, CG, DH, EI, and BK, (fig. 17.) respectively equal to the perpendicular distance of the points C, O, P, Q, and N. From the line AN (fig. 18.), and through the extremities of these lines, draw the curve FGHIK.

It remains to lay down the projection of the fashion-piece on the plane of elevation. In order to which, divide the line AB, fig. 20. (equal to AB, fig. 17.) into four equal parts, and through the points of division draw the perpendiculars AF, CG, DH, EI, and BK;

Fig. 20.

make AF (fig. 20.) equal to the perpendicular distance of the point C from the line BL (fig. 18.). In like manner make the lines CG, DH, EI, and BK (fig. 20.) respectively equal to the perpendicular distances of the points O, P, Q, and N, from the line BL (fig. 18.); and a curve drawn through these points will be the projection of the fashion-piece on the plane of elevation.

PROB. IX. To describe the intermediate frames in the after body.

For this purpose the midship and stern frames must be drawn in the plane of projection. As the main frame contains the greatest capacity, and the stern frame is that having the least, it hence follows that the form and dimensions of the intermediate frames will be between these; each frame, however, partaking most of the form of that to which it is nearest.

Fig. 21.

Let ACDE (fig. 21.) be the main frame on the plane of projection, and FGH the stern frame; and let there be any convenient number of intermediate frames, as *nine*. Draw the floor ribband CF, and the breadth ribband GD. Divide the curves CD, FG, each into the same number of equal parts, as three, in the points K, M; L, N; and draw the second and third ribbands KL, MN. In order to divide these ribbands so as to form fair curves in different sections, various methods have been proposed. One of the best of these, being that which is chiefly employed by the French construc-

 tors

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tors is by means of an equilateral triangle, which is constructed as follows.

Fig. 22. Draw the line ME (fig. 22.), limited at M, but produced towards E: take M 1 equal to any convenient extent; make 1, 2 equal to thrice that extent, 2, 3 equal to five times, and 3, 4 equal to seven times the above extent; and continue this division to E, always increasing by two, until there be as many points as there are frames, including the main and stern frames. Upon ME describe the equilateral triangle MSE, and draw lines from the vertex S to each point of division; then the line SM will be that answering to the main frame, and SE that corresponding to the post; and the other lines will be those answering to the intermediate frames in order.

Fig. 23. Let fig. 23. be the projection of part of the stern on the plane of elevation, together with the eighth and ninth frames. From the points L, N, G, (fig. 21.) draw the lines LO, NP, GQ, perpendicular to the plane of the upper edge of the keel. Make AB (fig. 23.) equal to AF (fig. 21.), and draw the water line BCD. Draw the line BC (fig. 22.) so that it may be parallel to the base of the triangle, and equal to CD (fig. 23.), which produce indefinitely towards H. Make BD equal to BC (fig. 23.), and draw the dotted line SD (fig. 22.). The ribband FC (fig. 21.) is to be applied to the triangle, so that it may be parallel to the base, and contained between the line MS and the dotted line SD. Let *cf* represent this line; then transfer the several divisions from *cf* to the ribband CF (fig. 21.), and number them accordingly. Again, make EF (fig. 23.) equal to LO (fig. 21.), and draw the water line FGH; make BF (fig. 22.) equal to FG (fig. 23.), and draw the dotted line SF; apply the second ribband LK to the triangle, so that the extremity K may be on the line SM, and the other extremity L on the dotted line SF, and making with SM an angle of about 62½ degrees. Let *kl* be this line, and transfer the divisions from it to the ribband KL. In like manner make IK (fig. 23.) equal to NP (fig. 21.), and draw the water line KLM. Make BG (fig. 22.) equal to KL (fig. 23.), and draw the dotted line SG; then the ribband MN is to be applied to the triangle in such a manner that its extremities M and N may be upon the lines SM, SG respectively, and that it may make an angle of about 68 degrees with the line SM; and the divisions are to be transferred from it to the ribband MN. The same process is to be followed to divide the other ribbands, observing to apply the fourth ribband to the triangle, so that it may make an angle of 86 degrees with the line SM; the fifth ribband to make an angle of 65 degrees, and the sixth an angle of 60 degrees with the line SM.

The quantities of these angles are, however, far from being precisely fixed. Some constructors, in applying the ribbands to the triangle, make them all parallel to its base; and others vary the measures of these angles according to fancy. It may also be remarked, that a different method of dividing the base of the triangle is used by some. It is certainly proper to try different methods; and that is to be preferred which best answers the intended purpose.

Beside the frames already mentioned, there are other two laid down by some constructors in the several plans, called *balance frames*. The after balance frame is placed at one fourth of the length of the ship before the sternpost; and the other, commonly called the *loof frame*, at one fourth of the ship's length aft of a perpendicular to the keel from the rabbet of the stem. Let the dotted line at X, between the fifth and sixth frames, (fig. 23.) be the place of the after balance frame in the plane of elevation. Then, in order to lay down this frame in the plane of projection, its representation must be previously drawn in the triangle. To accomplish this, draw the line SV (fig. 22.) so that the interval 5V may have the same ratio to 5 6 (fig. 22.) that 5 X has to 5 6 (fig. 23.) (D). Then the several points in the ribbands in the plane of projection answering to this frame are to be found by means of the triangle in the same manner as before.

The loof frame is nearly of the same dimensions as the after balance frame, or rather of a little greater capacity, in order that the centre of gravity of that part of the ship may be nearly in the plane of the midship frame. Hence the loof frame may be easily drawn in the plane of projection, and hence also the other frames in the fore body may be readily described.

PROB. X. To describe the frames in the fore body.

Draw the middle line of the stem AB (fig. 24.); make AC, BD each equal to half the thickness of the stem, and draw the line CD; describe also one half of the main frame CEFGHI. Let *e* E, *f* F, *g* G, *h* H, be water lines at the heights of the ribbands on the main frame; also let *a* be the termination of the floor ribband, and *b* that of the breadth ribband on the stem. Divide the interval *a b* into three equal parts in the points *c*, *d*, and draw the ribbands *a* E, *c* F, *d* G, and *b* H. Make *ei*, *fk*, *gl*, *hm* (fig. 24.) equal to *ei*, *fk*, *gl*, *hm* (fig. 21.) respectively, and draw the curve C*iklm*, which will be the projection of the loof frame. Or since it is necessary that the capacity of the loof frame should be a little greater than that of the after balance frame, each of the above lines may be increased by a proportional part of itself, as one tenth or one twentieth, as may be judged proper. Fig. 24.

Construct the triangle (fig. 25.) in the same manner as fig. 22. only observing, that as there are fewer frames in the fore than in the after body, its base will therefore be divided into fewer parts. Let there be eight frames in the fore body, then there will be eight divisions in the base of the triangle beside the extremes. Fig. 25.

Let fig. 26. represent the stem and part of the forebody in the plane of elevation, and let O be the place of the loof frame. Divide the interval 4, 5 (fig. 25.) so that 4, 5 may be to 4 Z as 4, 5 to 4, o (fig. 26.), and draw the dotted line SZ, which will be the line denoting the loof frame in the triangle.

Draw the lines AB, CD, EF, GH (fig. 26.) parallel to the keel, and whose perpendicular distances therefrom may be equal to C *a*, C *c*, C *d*, C *b*, (fig. 24.) the intersections Fig. 26.

(D) It is evident, from the method used to divide the base of the triangle, that this proportion does not agree exactly with the construction: the difference, however, being small, is therefore neglected in practice.

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interfections of thefe lines with the rabbet of the ftem, namely, the points I, K, L, M will be the points of termination of the feveral ribbands on the ftem in the plane of elevation. Divide S A (fig. 25.) fo that 8 B, 8 C, 8 D, and 8 E, may be refpectively equal to BI, DK, FL, and HM (fig. 26.), and draw the dotted lines SB, SC, SD, SE (fig. 25.). Apply the edge of a flip of card to the firft ribband (fig. 24.), and mark thereon the extremities of the ribband *a*, E, and alfo the point of interfection of the loof frame. Then apply this flip of card to the triangle in fuch a manner that the point *a* may be on the dotted line SB, the point E on the line SM, and the point anfwering to the loof frame on the dotted line SZ; and mark upon the card the feveral points of interfection of the lines S 1, S 2, &c. Now apply the card to the ribband *a* E (fig. 24.) as before, and transfer the feveral points of divifion from it to the ribband. In like manner proceed with the other ribbands; and lines drawn through the correfponding points in the ribbands will be the projection of the lower part of the frames in the fore body. The projections of the top-timbers of the feveral frames may be taken from the half breadth plan; and hence each top-timber may be eafily defcribed.

In large fhips, particularly in thofe of the French navy, a different method is employed to form the top-timbers in the fore body, which is as follows:

Plate ccccLxxxix. Fig. 27.

Let BI (fig. 27.) be one fourth of the breadth of the fhip, and draw IK parallel to AB. Take the height of the foremoft frame from the plane of elevation, and lay it off from A to B: from the point B draw BH perpendicular to AB, and equal to half the length of the wing tranfom. Let E be the place of the breadth ribband on the main frame, and F its place on the ftem at the height of the wing tranfom. With a radius equal to five fixths of half the greateft breadth of the fhip defcribe the quadrant EFG (fig. 28.): Make EH equal to FG (fig. 27.), the point F being at the height of the wing tranfom. Through H draw HO perpendicular to EH, and interfecting the circumference in O; then draw OL parallel to HE, and EL parallel to HO. Divide EL into as many equal parts as there are frames in the fore body, including the main frame, and from thefe points of divifion draw the perpendiculars 11, 22, &c. meeting the circumference as in the figure. Take the diftance 11, and lay it off from G (fig. 27.) towards F to the point 1; and from the fame point G lay off towards F the feveral perpendiculars contained between the ftraight line and the curve to the points 2, 3, &c. and through thefe points draw lines parallel to EG.

Fig. 28.

Fig. 29.

Take any line AB (fig. 29.) at pleafure: divide it equally in two in the point 8: divide 8 B in two parts in the point 7, and continue this method of divifion until there are as many points as there are frames in the fore body, including the main frame. Upon AB conftruct the equilateral triangle ACB, and draw the lines C 8, C 7, &c. Place a flip of card on the parallel *a* K 8 (fig. 27.), and mark thereon the points oppofite to *a*, K, and 8; and let them be denoted accordingly. Then apply this flip of card to the triangle, fo that the point *a*, which is that anfwering to the rabbet of the ftem, may be on the line AC; that the point anfwering to K may be on C 8, and the extremity 8 on the line CB; and mark on the card the points of interfection of the lines C 7, C 6, &c. and number them accordingly. Now apply this flip of card to the feventh parallel (fig. 23.), the point *a* being on the line CD, and mark on this parallel the point of interfection 7; flide the card down to the fixth parallel, to which transfer the point N° 6. In like manner proceed with the other parallels.

The point K, at the interfection of the line IK with the eighth parallel, is one point through which the eighth frame paffes. From this point upwards a curve is to be defcribed fo as to reconcile with the lower part of this frame already defcribed, and the upper part, forming an inverted arch, which is to terminate at H. This top-timber may be formed by two fweeps, whofe radii and centres are to be determined partly from circumftances and partly according to fancy. It however may be more readily formed by hand.

Let LM (fig. 27.) be the line of the fecond deck at the main frame, and let LN be the difference of the draught of water, if any. Make GN (fig. 28.) equal to LN: draw NM perpendicular to GN, meeting the circle in M; and through the points G and M draw the parallels GV and MV; divide GN as before, and from the feveral points of divifion draw perpendiculars terminating in the curve. Transfer thefe perpendiculars from L upwards (fig. 27.), and through the points thus found draw the lines 11, 22, &c. parallel to LM. Apply a flip of card to the eighth parallel, and mark upon it the point anfwering to the ftem, the eighth and main frames: carry this to the triangle, and place it fo that thefe points may be on the correfponding lines. Then the points of interfection of the lines C 7, C 6, &c. are to be marked on the card, which is now to be applied firft to the eighth parallel (fig. 27.), then to the feventh, &c. transferring the feveral points of divifion in order as before.

Draw the line HO (fig. 27.); mark its length on a flip of card, and apply it to the triangle, fo that it may be parallel to its bafe, and its extremities one on the eighth and the other on the main frame: mark on the card the points of interfection of the feveral intermediate lines as before; then apply the card to HO, and transfer the divifions.

There are now three points determined through which each top-timber muft pafs, namely, one in the breadth ribband, one in the fifth, and one in the upper ribband. Through thefe curves are to be defcribed, fo as to reconcile with the lower part of the frame, and partake partly of the curvature of the eighth frame, and partly of that of the main frame, but moft of that of the frame to which it is neareft: and hence the plane of projection is fo far finifhed, that it only remains to prove the feveral frames by water lines.

Another method of defcribing the frames in the body plan is by fweeps. In this method it is neceffary, in the firft place, to defcribe the height of the breadth lines, and the rifing of the floor, in the plane of elevation. The half breadth lines are next to be defcribed in the floor plan. The main frame is then to be defcribed by three or more fweeps, and giving it fuch a form as may be moft fuitable to the fervice the fhip is defigned for. The lower, upper, and top-timber heights of breadth, and the rifings of the floor, are to be fet upon the middle line in the body plan, and the feveral half breadths are then to be laid off on lines drawn through

thefe

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these points perpendicular to the middle line. A mould may then be made for the main frame, and laid upon the feveral rifings, as in whole mouldings, explained in Chapter V. with this difference, that here an under breadth fweep is defcribed to pafs through the point which limits the half breadth of the timber, the centre of which will be in the breadth line of that timber. The proper centres for all the frames being found, and the arches defcribed, the bend mould muft be fo placed on the rifing line of the floor, that the back of it may touch the back of the under breadth fweep. But the general practice is, to defcribe all the floor fweeps with compaffes, as well as the under breadth fweeps, and to reconcile thefe two by a mould which is an arch of a circle, its radius being the fame with that of the reconciling fweep by which the midfhip frame was formed. It is ufual for all the floor fweeps to be of the fame radius; and in order to find their centres a line is formed on the floor plan for the half breadth of the floor. As this line cannot be defcribed on the furface of a fhip, it is therefore only an imaginary line. Inftead of it fome make ufe of a diagonal in the body plane to limit the half breadth of the floor upon every rifing line, and to erect perpendiculars at the feveral interfections, in the fame manner as for the midfhip frame.

After the fweeps are all defcribed, recourfe is had to moulds, or fome fuch contrivance, to form the hollow of the timbers, much in the fame manner as in whole moulding; and when all the timbers are formed, they muft be proved by ribband and water lines, and altered, if neceffary to make fair curves.

The preceding methods of defcribing the feveral planes or fections of a fhip being well underftood, it will be a very eafy matter to conftruct draughts for any propofed fhip: and as the above planes were defcribed feparately and independent of each other, it is therefore of little confequence which is firft defcribed. In the following application, however, the plane of elevation will be firft drawn, then part of the floor plan, and laftly the body plan: and in connecting thefe plans the moft rational and fimple methods will be employed.

CHAP. IV. *Application of the foregoing Rules to the Conftruction of Ships.*

SECT. I. *To conftruct a Ship intended to carry a confiderable Burden in Proportion to her general Dimenfions, and to draw little Water.*

DIMENSIONS.

	F.	In.
Length between the wing tranfome and a perpendicular from the rabbet of the ftem at the height of breadth line	80	0
Main half breadth moulded	11	0
Half breadth at the height of breadth line at the ftern	7	6
Top-timber half breadth	10	6
Height of the ftem above the upper edge of the keel	17	0
Height of the breath line at the ftem	13	6
Height of the breadth line at the ftern	12	3
Upper height of breadth at the main frame	7	4
Lower height of breadth	5	10
Height of middle line of wales at the ftem	10	0

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Application of the foregoing Rules to the Conftruction of Ships.

	F.	In.
Height of middle line of wales at the main frame	6	10
Height of middle line of wales at the ftern	10	6
Breadth of the wales	1	9
Height of top-timber at midfhips	14	0
——— at ftern	18	0

Plate CCCCXC. Fig. 30.

Draw the line ab (fig. 30.) equal to 80 feet, from a convenient fcale: divide it into as many equal parts plus one as there are to be frames, which let be 16, and through each point of divifion draw perpendiculars. Make bc equal to 17 feet, the perpendicular height of the top of the ftem above the upper edge of the keel, and defcribe the ftem by Prob. II. Make ad equal to $10\frac{1}{2}$ feet, the height of the middle line of the wales at the ftern, and ae equal to the propofed rake of the poft, which may be about 2 feet: join de; and draw the line fg reprefenting the aft-fide of the poft. Defcribe the counter and ftern by Problem VI. and VII. Make $\oplus h$ equal to 14 feet, the top-timber height at the main frame, and ik equal to 18 feet, the height at the ftern; and through the three points c, h, k, defcribe the curve limiting the top-timbers by Problem I. Make bd equal to 10 feet, the height of the middle line of the wales at the ftem, and $\oplus$H equal to 6 feet 10 inches, the height at the main frame; and the curve dHd being defcribed will reprefent the middle line of the wales. At the diftance of $10\frac{1}{2}$ inches on each fide of this line draw two curves parallel thereto, and the wales will be completed in this plan. Make bl equal to $13\frac{1}{2}$ feet, the height of the breadth line at the ftem; am equal to $12\frac{1}{4}$ feet, the height at the ftern; and I$\oplus$ K$\oplus$ equal to 5 feet 10 inches and 7 feet 4 inches refpectively; and draw the upper breadth line lKm and lower breadth line lIm. From the line ab lay downwards the breadth of the keel, which may be about one foot, and draw the line Lt parallel to ab.

Let the line Lr, which is the lower edge of the keel, reprefent alfo the middle line of the floor plan. Produce all the perpendiculars reprefenting the frames: make $\oplus$ M (fig. 31.) equal to 11 feet, the main half breadth at midfhips; through m (fig. 30.) draw the line mN perpendicular to ab, and make pN equal to $7\frac{1}{2}$ feet, and draw the main half breadth line NMr by Problem IV. Defcribe alfo the top-timber half breadth line POr, $\oplus$O being equal to $10\frac{1}{2}$ feet, and form the projecting part of the ftem $qrst$. Fig. 31.

In order that the top-timber line may look fair on the bow, and to prevent the foremoft top-timbers from being too fhort, it is neceffary to lift or raife the fheer from the round of the bow to the ftem. For this purpofe the following method is ufually employed: Produce the circular fheer before the ftem in the plane of elevation at pleafure; then place a batton to the round of the bow in the half breadth plan, and mark on it the ftations of the fquare timbers and the fide of the ftem; apply the batton to the fheer plan, and place it to the fheer of the fhip, keeping the ftations of the timbers on the batton well with thofe on the fheer plan for feveral timbers before dead-flat, where they will not alter; then mark the other timbers and the ftem on the fheer line produced; through thefe points draw lines parallel to the keel, to interfect their correfponding timbers and the ftem in the fheer plan: then a curve defcribed thefe laft points will be the fheer of the fhip round the

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the bow, lifted as required : and the heights of the timbers thus lengthened are to be transferred to the body plan as before.

Plate cccclxxxiv. Fig. 32.

Draw the line AB (fig. 32.) equal to 22 feet, the whole breadth; from the middle of which draw the perpendicular CD: make CE equal to half the thickness of the post, and CF equal to half that of the stem, and from the points A, E, F, B, draw lines parallel to CD. Make AG, BG each equal to 14 feet, the height at the main frame, and draw the line GG parallel to AB. Make GH, GH each equal to half a foot, the difference between the main and top timber half breadths. From A and B set up the heights of the lower and upper breadth lines to I and K, and draw the straight lines IK, IK. Let CL be the rising at the main frame, and ⊕, ⊕ the extremities of the floor timber. Hence, as there are now five points determined in each half of the main frame, it may be very easily described.

Make CM equal to L⊕, join M⊕, and draw the other ribbands NO, PQ. In order, however, to simplify this operation, the rectilineal distance ⊕I was trisected, and through the points of division the lines NO, PQ were drawn parallel to the floor ribband M⊕.

Take the distance *b c* (fig. 30.), and lay it off from F to (fig. 32.); also make F*b* (fig. 32.) equal to F*u* (fig. 30.); through *b* draw *b c* parallel to AB, and equal to FR (fig. 31.). In like manner take the heights of each top-timber from fig. 30. and lay them off from C towards D (fig. 32.); through these points draw lines parallel to AB, and make them equal each to each, to the corresponding half breadth lines taken from the floor-plan: Then through the several points *a*, *c*, &c. thus found, draw a line *a c*H, which will be the projection of the top-timber line of the fore body in the body plan. Proceed in the same manner to find the top-timber line in the after body.

Transfer the height of the main-breadth line on the stem *b l* (fig. 30.), from F to *d* (fig. 32.). Transfer also the heights of the lower and upper breadth lines at timber F (fig. 30.), namely, FW, FX, from F to *e* and *f* (fig. 32.); through which draw the parallels *e g*, *f h*; make them equal to FS (fig. 31.), and draw the straight line *g h*. In this manner proceed to lay down the portions of the extreme breadth at each frame, both in the fore and in the after body in the body plan, and draw the upper and lower breadth lines *d h* K, *d g* I in the fore body and K*i*, I*i* in the after body. Hence the portions of the several top-timbers contained between the top-timber and main breadth lines may be easily described. It was before remarked that their forms were partly arbitrary. The midship top-timber has generally a hollow, the form of which is left entirely to the artist, though in some ships, especially small ones, it has none. It is the common practice to make a mould for this hollow, either by a sweep or some other contrivance, which is produced considerably above the top-timber line, in a straight line or very near one. The midship top-timber is formed by this mould, which is so placed that it breaks in four with the back of the upper breadth sweep. The other top-timbers are formed by the same mould, observing to place it so that the straight part of it may be parallel to the straight part of the midship timber, and moved up or down, still keeping it in that direction till it just touches the back of the upper breadth sweep. Some constructors begin at the after timber, after the mould is made for the midship top-timber, because they think it easier to keep the straight part of the mould parallel to this than to the midship timber; and by this means the top side is kept from winding. Others, again, make a mark upon the mould where the breadth line of the midship timber crosses it, and with the same mould they form the after timber: this will occasion the mark that was made on the mould when at the main frame to fall below the breadth line of the after timber, and therefore another mark is made at the height of the breadth line at the after timber; the straight part of the mould is then laid obliquely across the breadth lines of the top-timbers in such a manner that it may intersect the breadth line of the midship timber at one of these marks and the breadth line of the after timber at the other mark; then the several intersections of the breadth lines of the timbers are marked upon the mould; which must now be so placed in forming each timber, that the proper mark may be applied to its proper breadth, and it must be turned about so as just to touch the upper breadth sweep. Any of these methods may make a fair side, and they may be easily proved by forming another intermediate half breadth line.

The remaining parts of the frames may be described by either of the methods laid down in Problems IX. and X. In order, however, to illustrate this still farther, it is thought proper to subjoin another method of forming the intermediate frames, the facility of which will recommend it.

Take FZ (fig. 30.), and lay it from F to *k* (fig. 32.); then describe the lower part of the foremost frame, making it more or less full according as proposed; and intersecting the ribbands in the points *l*, *m*, *n*. Describe also the aftermost frame *o*, *p*, *q*. Make $\alpha\beta$ (fig. 30.) equal to F*r* (fig. 32.), and produce it to *a* (fig. 31.); also draw $\gamma\delta$ and $\epsilon\zeta$ (fig. 30.) equal to E*r* and E*s* (fig. 32.) respectively; and produce them to *b* and *c*: Make F*e*, F*f*, FR (fig. 31.) equal to M*l*, N*m*, P*n* (fig. 32.) each to each. Let also ⊕*h*, ⊕*i*, ⊕*k*, and 9*l*, 9*m*, 9*n* (fig. 31.) be made equal to M⊕, NO, PQ, and M*o*, N*q*, P*p* (fig. 32.); then through these points trace the curves *a e n h l b*, *r f i m c*, and *r* R *k n p*, and they will be the projections of the ribbands in the floor plane. Now transfer the several intervals of the frames contained between the middle line and the ribbands (fig. 31.) to the corresponding ribbands in the body plan (fig. 32.). Hence there will be five points given in each frame, namely, one at the lower breadth line, one at each ribband, and one at the keel; and consequently these frames may be easily described. In order to exemplify this, let it be required to lay down the frame E in the plane of projection. Take the interval E*n* (fig. 31.), and lay it from M to *u* (fig. 32). Lay off also E*v*, E*e* (fig. 31.) from N to *v* and from P to *n* (fig. 32.); then through the points F, *u*, *v*, *n* and the lower breadth line describe a curve, and it will be the representation of the frame E in the body plan. In like manner the other frames may be described.

The ribbands may now be transferred from the body plan to the plane of elevation, by taking the several heights of the intersection of each ribband with the frames, and laying them off on the corresponding frames in the floor plan; and if the line drawn through these points

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points make a fair curve, it is presumed that the curves of the frames are rightly laid down in the body plan. Only one of these ribbands, namely, the first, is laid down in fig. 30. These curves may also be farther proved, by drawing water lines in the plane of elevation, and in the body plan, at equal distances from the upper edge of the keel. Then the distances between the middle line of the body plan, and the several points of intersection of these lines with the frames, are to be laid off from the middle line in the floor plan upon the corresponding frames; and if the line drawn through these points form a fair curve, the frames are truly drawn in the body plan.

In figs. 30. and 32. there are drawn four water lines at any equal distances from the keel, and from each other. These lines are then transferred from fig. 32. to fig. 31.; and the lines passing through these points make fair curves.

The transoms are described by Problem VIII. it is therefore unnecessary to repeat the process. A rising line of the floor timbers is commonly drawn in the plane of elevation.

As this is intended only as an introductory example, several particulars have therefore been omitted; which, however, will be exemplified in the following section.

Sect. IV. *To describe the several Plans of a Ship of War proposed to carry* 80 *Guns upon two Decks.*

As it is proposed in this place to show the method of describing the plans of a ship of a very considerable size, it therefore seems proper to give the dimensions of every particular part necessary in the delineation of these plans. The several plans of this ship are contained in figs 33, and 34. But as it would very much confuse the figures to have a reference to every operation, and as the former example is deemed a sufficient illustration, the letters of reference are upon these accounts omitted in the figures.

Plate CCCCXCI. Figs. 33. & 34.

Principal Dimensions.

Ship Builder's Repository.

	F.	In.
Lengths.—Length on the gun or lower deck from the aft part of the rabbet of the stem to the aft part of the rabbet of the post	182	0
Length from the foremost perpendicular to dead flat	63	11¼
Length from the foremost perpendicular to timber Y	4	0
Length from after perpendicular to timber 37	3	4
Room and space of the timbers	2	8¼
Length of the quarter-deck from the aft part of the stern	95	0
Length of the forecastle from the fore part of the beak-head	49	0
Length of round-house deck from the aft part of the stern	51	8
Heights.—Height of the gun or lower deck from the upper edge of the keel to the under side of the plank at dead flat	24	0
Height of the gun or lower deck from the upper edge of the keel to the under side of the plank at foremost perpendicular	26	
Height of the gun or lower deck from the upper edge of the keel to the under side of the plank at after perpendicular	26	3
Height from the upper side of the gun-deck plank to the under side of the upper deck plank, all fore and aft	7	0
Height from the upper side of the upper deck plank to the under side of the greater deck plank — afore	6	10
— abaft	6	11
Height to the under side of forecastle plank, afore and abaft	6	6
Height from the upper side of the quarter deck plank to the under side of the round-house plank — afore	6	9
— abaft	6	10
Height of the lower edge of the main wales at foremost perpendicular	24	6
Height of the lower edge of the main wales at dead flat	20	0
Height of the lower edge of the main wales at after perpendicular	26	6
Height of the lower edge of the channel wales at foremost perpendicular	32	6
Height of the lower edge of the channel wales at dead flat	29	0
Height of the lower edge of the channel wales at after perpendicular	34	0
Height of the upper side of the wing transom	28	4
Height of the touch of the lower counter at the middle line	33	5
Height of the touch of the upper counter at the middle line	36	2
Height of the top-timber line at the after part of the stern timber	44	7
Breadths.—Main wales in breadth from lower to upper edge	4	6
Channel wales in breadth from lower to upper edge	3	0
Waist rail in breadth	0	7
Distance between the upper edge of the channel wales and the under edge of the waist rail	2	9
Sheer rail in breadth	0	6
Distance between the sheer rail and the rail above from timber 13 to the stern	2	5
Distance between the sheer rail and the rail above from timber 7 to timber 11	1	4
Distance between the sheer rail and the rail above from timber C to the forepart of beak-head	1	2
And the said rail to be in breadth	0	6
Plank sheer to be in thickness	0	2½
Centres of the masts.—From the foremost perpendicular to the centre of the mainmast on the gun-deck	103	2
From the foremost perpendicular to the centre of the foremast on the gun-deck	20	5
From the after perpendicular to the centre of the mizenmast on the gun-deck	28	6
Stem.—The centre of the sweep of the stem abaft timber P	0	4
Height of ditto from the upper edge of the keel	26	1
Stem moulded	1	3

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	F.	In.
Foremost part of the head afore the perpendicular - - -	2	4
Height of ditto from the upper edge of the keel - - -	38	3
Stern-post.—Aft part of the rabbet afore the perpendicular on the upper edge of the keel	3	4
Aft part of the port abaft the rabbet at the upper edge of the keel - -	2	6
Aft part of the port abaft the rabbet at the wing transom - - -	1	1
Stern-port fore and aft on the keel -	3	1
Ditto square at the head - -	2	$0\frac{1}{2}$
Counters.—The touch of the lower counter at the middle line, abaft the aft part of the wing transom - - -	7	6
Round aft of the lower counter -	1	4
Round up of the lower counter -	0	9
The touch of the upper counter at the middle line, abaft the aft part of the wing transom - - -	9	9
Round aft of the upper counter -	1	$3\frac{1}{2}$
Round up of the upper counter -	0	10
Aft part of the stern-timber at the middle line, at the height of the top timber line, abaft the aft part of the wing transom	12	6

	F.	In.
Round aft of the wing transom -	0	6
Round up of the wing transom -	0	$5\frac{1}{2}$
Draught of water.—Load draught of water from the upper edge of the keel - - afore	20	5
abaft	20	5
Channels.—Foremost end of the fore channel afore timber R - -	1	0
The channel to be in length -	37	0
And in thickness at the outer edge	0	$4\frac{1}{2}$
The dead eyes to be 12 in number, and in diameter - - -	1	6
Foremost end of the main channel afore timber 9 - - -	0	10
The channel to be in length -	38	0
And in thickness at the outer edge -	0	$4\frac{1}{2}$
The dead eyes to be 14 in number, and in diameter - -	1	6
Foremost end of the mizen-channel abaft timber 27 - - -	2	4
The channel to be in length -	20	0
And in thickness at the outer edge -	0	4
The dead eyes to be 7 in number, and in diameter - - -	1	0

DIMENSIONS of the several Parts of the Bodies.

Fore Body.	Timbers Names.															
	⊕		C		G		L		P		T		W		Y	
	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.
Lower height of breadth -	22	6	22	6	22	7	23	0	23	11	25	7	26	10	28	8
Upper height of breadth -	24	10	24	10	24	10	24	$10\frac{1}{2}$	25	$3\frac{1}{2}$	26	$4\frac{1}{2}$	27	$4\frac{1}{2}$	29	0
Height of the top-timber line -	37	5	37	7	38	0	38	5	39	1	39	10	40	4	40	9
Height of the rising line * -	0	0	0	$5\frac{1}{2}$	3	10	9	10	18	6						
Height of the cutting down -	2	$3\frac{1}{2}$	2	$3\frac{1}{2}$	2	$3\frac{1}{2}$	2	8	3	10	6	4				
Main half breadth - -	24	$5\frac{1}{2}$	24	$5\frac{1}{2}$	24	$4\frac{1}{2}$	24	$0\frac{1}{2}$	23	$2\frac{1}{2}$	20	2	17	0	11	$0\frac{1}{2}$
Top-timber half breadth -	20	11	20	10	20	9	20	6	20	0	18	$9\frac{1}{8}$	17	10	16	6
Half breadth of the rising -	8	7	8	4	6	$5\frac{1}{2}$	2	9	5 Outside	7						
Length of the lower breadth sweeps	19	2	18	9	18	3	17	3	15	11	14	1	12	7	12	0
First diagonal line -	7	9	7	$8\frac{3}{4}$	7	7	7	1	6	3	3	8				
Second ditto - -	13	9	13	$8\frac{1}{2}$	13	$4\frac{1}{2}$	12	1	10	3	7	$1\frac{1}{2}$	4	6		
Third ditto - -	20	0	19	11	19	2	17	7	15	1	11	1	8	$3\frac{1}{4}$	3	$4\frac{1}{2}$
Fourth ditto - -	23	$4\frac{1}{2}$	23	$4\frac{1}{2}$	23	0	21	$8\frac{1}{2}$	18	11	14	$8\frac{1}{2}$	11	5	6	0
Fifth ditto - - -	24	8	24	8	24	$4\frac{1}{2}$	23	$5\frac{1}{2}$	21	$2\frac{1}{2}$	17	1	13	$8\frac{1}{2}$	7	11
Sixth ditto - -																
Seventh ditto - - -	24	$1\frac{1}{2}$	24	$1\frac{1}{2}$	24	0	23	9	22	10	20	$10\frac{1}{2}$	18	$6\frac{1}{2}$	14	7

* Rising height 11 feet 10 inches at dead flat, from which all the other risings must be set off.

After Body.	Timbers Names.																					
	1		5		9		13		17		21		25		29		33		35		37	
	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.
Lower height of breadth	22	6	22	6	22	6	20	7½	22	9	23	0½	27	7½	24	6	25	10¾	26	9¾	28	3
Upper ditto	24	10	24	10	24	10	24	11	25	1	25	4	25	8	26	3	27	1	27	9	28	8
Height of the top-timber line	37	5	37	5	37	6	37	10	38	3½	38	11	39	8	40	6	41	5	42	0	42	6
Height of the cutting down	2	3½	2	3½	2	3½	2	3½	2	4	2	7½	3	5	5	2½	8	7				
Height of the rifing	0	2½	0	8½	1	9½	3	6½	6	0	10	1	17	0								
Main half breadth	24	5¼	24	4¾	24	4¼	24	3¼	24	1	23	8½	23	0½	21	10						
Half breadth of the rifing	8	6	8	3	7	9	6	10½	5	3½	2	8	2	6	Outfide							
Top-timber half breadth	20	11	20	10	20	9½	20	9	20	7	20	3	19	5	18	2	16	8	15	10½	15	0¼
Topfides half breadth											19	7	18	4	17	0	15	10	14	11	14	3
Length of lower breadth fweeps	19	2	19	2	19	0	18	7	17	1	16	0	14	5	12	5	9	10½	7	11	4	8
Firft diagonal	7	9	7	8¼	7	7	7	5	7	2½	6	7	5	9	4	7	2	10	1	8½	0	7
Second ditto	13	9	13	8½	13	6	13	1	12	6	11	2	9	7	7	7	4	8¼	3	1	0	11
Third ditto	20	0	19	11¼	19	7½	19	0	18	1½	16	6	14	2	11	5½	7	8½	5	5	2	1½
Fourth ditto	23	4½	23	3	23	1½	22	6½	21	11	20	3	18	0½	15	3½	11	4	8	7	4	6¼
Fifth ditto	24	8	24	7	24	6	24	1½	23	6½	22	3½	20	6½	18	2	14	4	11	5	7	0
Sixth ditto																	18	8½	16	0	11	8
Seventh ditto											23	9½	23	0	21	8½	20	0	18	11	17	8¾

DIAGONAL LINES for both the FORE and AFTER BODIES.

Fore and After Bodies.	Names of the Diagonal Lines.													
	1ft		2d		3d		4th		5th		6th		7th	
	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.
Height up the middle line	6	11	11	4	16	5¼	20	8	23	5¼	27	5	43	9
Diftance from the middle line on the bafe line	4	8	9	1	15	6								
Height up the fide line							0	9½	6	7	12	7½	32	8½

I. *Of the Sheer Draught or Plane of Elevation.*

Fig. 33. Draw a ftraight line (fig. 33.) to reprefent the upper edge of the keel, erect a perpendicular on that end to the right, and from thence fet off 182 feet, the length on the gun-deck, and there erect another perpendicular; that to the right is called the *foremoft* perpendicular, and the other the *after* one: upon thefe two perpendiculars all the foremoft and aftermoft heights muft be fet off, which are expreffed in the dimenfions.

Then fet off the diftance of the main frame or dead flat from the foremoft perpendicular, and at that place erect a third perpendicular, which muft be diftinguifhed by the character ⊕. From dead flat the room and fpace of all the timbers muft be fet off; but it will only be neceffary to erect a perpendicular at every frame timber; which in the fore body are called *dead flat*, A, C, E, &c. and in the after body (2), 1, 3, 5, &c.: hence the diftance between the frame perpendiculars will be double the room and fpace expreffed in the dimenfions. Then fet off the heights of the gun-deck afore at midfhip or dead flat, and abaft from the upper fide of the keel; and a curve defcribed through thefe three points will be the upper fide of the gun-deck. Set off the thicknefs of the gun-deck plank below that; and another curve being drawn parallel to the former, the gun-deck will then be defcribed at the middle line of the fheer plan.

The centre of the ftem is then to be laid down by means of the table of dimenfions; from which centre, with an extent equal to the neareft diftance of the upper edge of the keel, defcribe a circle upwards: defcribe alfo another circle as much without the former as the ftem is moulded. Then fet off the height of the head of the ftem, with the diftance afore the perpendicular, and there make a point; and within that fet off the moulding of the ftem, and there make another point · from this laft mentioned point let a line pafs downwards, interfecting the perpendicular at the height of the gun-deck, and breaking in fair with the inner circle, and the after part of the ftern is drawn. Draw another line from the foremoft point downwards, parallel to the former, and breaking in fair with the outer circle; then the whole ftem will be formed, except the after or lower end, which cannot be determined till hereafter.

The ftern-poft muft be next formed. Set off on the upper edge of the keel a fpot for the aft part of the rabbet taken from the dimenfions, and from that forward fet off another point at the diftance of the thick-

nefs

nefs of the plank of the bottom, which is four inches and a half; and from this laft-mentioned point draw a line upwards interfecting the perpendiculars at the height of the lower deck; then fet up the perpendicular the height of the wing tranfom, and draw a level line, and where that line interfects, the line firft drawn will be the aft fide of the wing tranfom; on the upper part of the middle line fet off from that place the diftance of the aft fide of the ftern-poft; fet off alfo the diftance of the after part from the rabbet on the upper edge of the the keel, and a line drawn through thefe two points will be the aft fide of the poft. A line drawn parallel to the firft drawn line at the diftance of four inches and a half, the thicknefs of the plank on the bottom, will be the aft fide of the rabbet: and hence the ftern-poft is defcribed, except the head, which will be determined afterwards.

From the dimenfions take the feveral heights of the upper deck above the gun-deck, afore, at midfhip, and abaft, and fet them off accordingly; through thefe points defcribe a curve, which will be the under fide of the upper deck; defcribe alfo another curve parallel thereto, at the diftance of the thicknefs of the plank, and the upper deck will be then reprefented at the middle line of the fhip.

Set off the height of the lower counter, at the middle line, from the upper edge of the keel, and draw a horizontal line with a pencil; then on the pencil line fet off the diftance the touch of the lower counter is abaft the aft fide of the wing tranfom: from this point to that where the fore part of the rabbet of the ftern-poft interfects the line drawn for the upper part of the wing tranfom, draw a curve at pleafure, which curve will reprefent the lower counter at the middle line. The height of the upper counter is then to be fet off from the upper edge of the keel, and a horizontal line is to be drawn as before, fetting off the diftance the touch of the upper counter is abaft the aft fide of the wing tranfom; and a curve defcribed from thence to the touch of the lower counter will form the upper counter at the middle line.

Both counters being formed at the middle line, the upper part of the ftern timber above the counters is to be defcribed as follows: On the level line drawn for the upper fide of the wing tranfom fet off the diftance of the aft fide of the ftern timber at the middle line from the aft fide of the wing tranfom, at the height of the top-timber line, and erect a perpendicular: then upon this perpendicular, from the upper edge of the keel, fet off the height at the middle line of the top-timber line at the after fide of the ftern timber; through this point draw a ftraight line to the touch of the upper counter, and the upper part of the ftern timber will be defcribed.

As the ftern rounds two ways, both up and aft, the ftern timber at the fide will confequently alter from that at the middle line, and therefore remains to be reprefented. Take the round up of the upper counter from the dimenfions, and fet it below the touch at the middle, and with a pencil draw a level line; take alfo the round aft, and fet it forward from the touch on the touch line, and fquare it down to the pencil line laft drawn, and the point of interfection will be the touch of the upper counter at the fide. In the fame manner find the touch of the lower counter; and a curve, fimilar to that at the middle line, being defcribed from the one touch to the other, will form the upper counter at the fide.

Take the round up of the wing tranfom, and fet it off below the line before drawn for the height of the wing tranfom, and draw another horizontal line in pencil: then take the round aft of the wing tranfom, and fet it forward on the upper line from the point reprefenting the aft fide of the wing tranfom; fquare it down to the lower line, and the interfection will be the touch of the wing tranfom: then a curve, fimilar to that at the middle line, being drawn from the touch of the wing tranfom to the touch of the lower counter at the fide, will be the lower counter at the fide. Draw a line from the upper counter upwards, and the whole ftern timber at the fide will be reprefented. But as the ftraight line drawn for the upper part of the fide timber fhould not be parallel to that at the middle line, its rake is therefore to be determined as follows.

Draw a line at pleafure, on which fet off the breadth of the ftern at the upper counter; at the middle of this line fet off the round aft of the upper counter, then through this point and the extremities of the ftern defcribe a curve. Now take the breadth of the ftern at the top-timber line, and through the point where that breadth will interfect the curve for the round aft of the ftern draw a line parallel to that firft drawn, and the diftance from the line laft drawn to the curve at the middle of the line is the diftance that the fide timber muft be from the middle line at the height of the top-timber line.

The fheer is to be defcribed, which is done by fetting off the heights afore, at midfhips, and abaft; and a curve defcribed through thefe three points will be the fheer. But in order that the fheer may correfpond exactly with the dimenfions laid down, it will be neceffary to proceed as follows: The perpendicular reprefenting timber dead flat being already drawn, fet off from that the diftances of the other frame timbers, which is double the room and fpace, as the frames are only every other one; and erect perpendiculars, writing the name under each: then on each of thefe perpendiculars fet off the correfponding heights of the top-timber line taken from the table of dimenfions for conftructing the bodies; and through thefe points a curve being defcribed, will reprefent the fheer of the fhip or top-timber line agreeable to the dimenfions.

The quarter-deck and forecaftle are next to be defcribed, which may be done by taking their refpective heights and lengths from the dimenfions, and defcribing their curves. In the fame manner alfo, the round-houfe may be drawn. The decks being defcribed reprefenting their heights at the middle, it is then neceffary to reprefent them alfo at the fide. For this purpofe take the round of the decks from the dimenfions, and fet them off below the lower line drawn for the middle; and a curve defcribed both fore and aft, obferving to let it be rather quicker than the former, will be the reprefentation of the decks at the fide.

The ports come next under confideration. In the placing of them due attention muft be paid, fo as to preferve ftrength; or that they fhall be fo difpofed as not to weaken the fhip in the leaft, which is often done by cutting off principal timbers, placing them in too large openings, having too fhort timbers by the fide of them,

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them, &c. The frames reprefented by the lines already drawn muft be firft confulted. Then with a pencil draw two curves, for the lower and upper parts of the lower deck pofts, parallel to the line reprefenting the lower deck; the diftances of thefe lines from the deck are to be taken from the dimenfions, obferving, however, to add to thefe heights the thicknefs of the deck, as the deck line at the fide reprefents the under part of the deck.

The foremoft port is then to be defcribed, obferving to place it as far aft as to give fufficient room for the manger: the moft convenient place will therefore be to put it between the frames R and T, and equally diftant from each. It will then be placed in the moft confpicuous point of ftrength, as it will have a long top-timber on the aft fide and a long fourth futtock on the fore fide of it. The fecond port may be placed in like manner between the next two frames, which will be be equally well fituated for ftrength as the former; and by proceeding in this manner, the ports on the gun deck may alfo be placed, taking care to have two frames between every two ports, all fore and aft.

The upper deck ports are then to be defcribed; and in order to difpofe of them in the ftrongeft fituation poffible, they muft be placed over the middle between the gun-deck ports, fo that every frame in the fhip will run up to the top of the fide, by their coming between a gun and upper deck port; and every port will be between the frames, which will in a great meafure contribute towards the ftrength of the fhip. With regard to the ports on the quarter deck, it is not of fuch material confequence if they cut the head of the frame, as in placing them the fituation of the dead eyes muft be confidered, placing a port where there is a vacancy between the dead eyes large enough to admit of one; obferving always to place them as nearly as poffible at equal diftances from each other; and where it happens that they do not fall in the wake of a frame, then that frame muft by all means be carried up to the top of the fide.

The neceffary length of the round houfe being determined in the dimenfions, it may be fet off; obferving, however, to let it be no longer than is juft fufficient for the neceffary accommodations, as the fhorter the round-houfe the works abaft may be kept lower, and a low fnug ftern is always accounted the handfomeft. Then fet off the round of the deck at the foremoft end, below the line drawn; the deck at the fide may be defcribed by another curve drawn quite aft. Now, from the point for the round of the deck to the ftern-timber, draw a curve parallel to the top-timber line, and that will be the extreme height of the top of the fide abaft, which height continues to range fair along to the foremoft end of the round-houfe, and at that place may have a fall about 14 inches, which may be turned off with a drift fcroll. At the fore part of the quarter-deck, the topfide may have a rife of 14 inches, which may alfo be turned off with a fcroll. But as the raifing of the topfide only 14 inches at that place will not be fufficient to unite with the heights abaft, it will therefore be neceffary to raife 14 inches more upon that, and break it off with a fcroll inverted on the firft fcroll, and continue thefe two lines, parallel to the top-timber line, to the diftance of about feven feet aft. At the foremoft end of the round-houfe there is a break of 14 inches already mentioned; and in order to make that part uniform with the breaks at the foremoft end of the quarter-deck, there muft be fet down 14 inches more below the former; and at thefe two heights continue two curves parallel to the top-timber line, from the aft part of the ftern to the ends of the two curves already drawn at the foremoft end of the quarter-deck. If they fhould happen not to break in fair with them, they muft be turned off with a round; but to make them appear more handfome, the lower line may be turned off with a fcroll. Thefe lines being drawn will reprefent the upper edges of the rails.

The height of the top fide at the fore part of the fhip muft next be confidered; which, in order to give proper height for the forecaftle, muft have a rife there of 14 inches, the break being at the after end of the forecaftle, and turned off as before. But as this part of the fhip is ftill confiderably lower than the after part, it will be neceffary to give another of eight inches upon the former, and turn it off with a fcroll inverted. Hence this part of the fhip will appear more uniform to the after part.

The finifhing parts, namely the wales, ftern, head, rails, &c. remain to be defcribed. The wales may be firft drawn; and as the ftrength of the fhip depends very much on the right placing of them, great care muft therefore be taken that they may be as little as poffible wounded by the lower deck ports, and fo placed that the lower deck bolts fhall bolt in them, and alfo that they come as near as poffible on the broadeft part of the fhip. In the firft place, therefore, the height of breadth lines muft be chofen for our guide. Thefe heights of breadth are to be taken from the dimenfions, and fet off on the refpective frames, and curves drawn through thefe points will be the upper and lower heights of breadth lines. The height of the wales may be now determined; which in general is in fuch a manner that the upper height of breadth line comes about fix inches below their upper edge, and the wales are then placed right upon the breadth lines. Take the heights and breadths of the wales afore, at midfhips, and abaft, from the table of dimenfions; draw curves through the points thus found, and the wales will be reprefented.

The channel wales are then to be defcribed. They are principally intended to ftrengthen the top fide, and muft be placed between the lower and upper deck ports; and the lower end of them at midfhips fhould be placed as low as poffible, in order to prevent them from being cut by the upper deck ports afore and abaft. Take their heights and breadths from the dimenfions; lay them off, and defcribe curves through the correfponding points, and the channel wales will be reprefented.

Lay off the dimenfions of the wafte rail found in the table; and through the points draw a line parallel to the top timber line all fore and aft. This rail terminates the lower part of the paint work on the top fide, as all the work above this rail is generally painted, and the work of the top fide below it payed with a varnifh, except the main wales, which are always payed with pitch.

Take the draught of water from the dimenfions, and draw the load water-line, which is always done in green. Divide the diftance between the load water-line and the upper edge of the keel into five equal parts, and through thefe points draw four more water-lines.

Set

Application of the foregoing Rules to the Construction of Ships.

Set off the centres of the masts on the gun-deck; their rake may likewise be taken from the dimensions. Set off also the centre of the bowsprit, letting it be four feet from the deck at the after part of the stem, which will give sufficient height for a light and airy figure.

Draw the knight-heads so as to be sufficiently high above the bowsprit to admit of a chock between them for the better security of the bowsprit. The timber heads may also be drawn above the forecastle, observing to place the most convenient for the timbers of the frame, being those which come over the upper deck ports, as they may be allowed long enough to form handsome heads. There should be one placed abaft the cat-head, to which the foremost block is to be bolted, and there may be two ports on the forecastle formed by them, and placed where it is most convenient to the dead eyes.

Describe the channels, taking their lengths and thicknesses from the dimensions, and place their upper edges well with the lower edge of the sheer rail. The dead eyes may then be drawn, observing to place them in such a manner that the chains may not interfere with the ports; and the preventer plates must all be placed on the channel wales, letting them be of such a length that the preventer bolt at each end may bolt on each edge of the channel wales. It must also be observed to give each of the chains and preventer plates a proper rake, that is, to let them lie in the direction of the shrouds, which may be done in the following manner: Produce the mast upwards, upon which set off the length of the mast to the lower part of the head; these straight lines drawn from that point through the centre of each dead eye will give the direction of the chains and preventer braces.

The fenders may be then drawn, observing to place them right abreast of the main hatchway, in order to prevent the ship's side from being hurt by whatever may be hoisted on board. The proper place for them will therefore be at timber 3; and the distance between them may be regulated by the distance between the ports. The chest-tree may also be drawn, which must be placed at a proper distance abaft the foremast, for the conveniency of hauling home the fore tack. It may therefore be drawn at the aft side of timber C from the top of the side down to the upper edge of the channel wales; and the fenders may reach from the top of the side down to the upper edge of the main wales. As the fenders and chest tree are on the outside of the planks, wales, &c. the lines representing the wales, &c. should not be drawn through them.

Draw the steps on the side, which must be at the fore part of the main drift or break, making them as long as the distance between the upper and lower deck ports will admit of. They may be about six inches asunder, and five inches deep, and continued from the top of the side down to the middle of the main wales.

In order to describe the head, the height of the beak-head must be first determined, which may be about two feet above the upper deck. At that place draw a horizontal line, upon which set off the length of the beak-head, which may be $7\frac{1}{2}$ feet abaft the fore part of the stem, and from thence square a line up to the forecastle deck; which line will represent the aft part of the beak head, and will likewise terminate the foremost end of the forecastle. The length of the head may now be determined, which by the proportions will be found to be 15 feet six inches from the fore part of the stem. Set it off from the fore part of the stem, and erect a perpendicular, which will be the utmost limits of the figure forward: then take the breadth of the figure from the proportions, which is four feet four inches, and set it off forward; and another perpendicular being drawn will show the utmost extent of the hair bracket forward, or aft part of the figure. Then draw the lower cheek, letting the upper edge be well with the upper edge of the main wales, and the after end ranging well with the beak head line; set off the depth of it on the stem; which is about 11 inches, and let a curved line pass from the after end through the point on the stem, and to break in fair with the perpendicular first drawn for the length of the head, the fore part of the curve will then represent the position of the figure.

The upper cheek may next be drawn; but, in order to know the exact place of it on the stem, the place of the main rail must first be set off on the stem, the upper edge of which may be kept on a level with the beak-head; then setting off the depth of it below that, the place for the upper cheek may be determined, letting it be exactly in the middle between that and the lower cheek: then, by drawing curves for the upper and lower edges of the cheek from the after end parallel to the lower cheek, to break in fair with the perpendicular, drawn for the back of the figure: then the upper cheek will be formed. The upper part may run in a serpentine as high as where the shoulder of the figure is supposed to come, at which place it may be turned off with a scroll. The distance from the scroll to the heel of the figure is called the hair bracket.

The head of the block may be formed by continuing the line at the breast round to the top of the hair-bracket, observing to keep the top of it about six inches clear of the under side of the bowsprit.

Having the distance set off on the stem for placing the main rail, it may next be described, keeping the bag of it as level as possible for the conveniency of the gratings, and letting the foremost end rise gradually according to the rise of the upper cheek and hair bracket, and may turn off on the round of the scroll before drawn for the hair-bracket. To form the after end, set off the size of the head of the rail abaft the beak-head line, and erect a perpendicular; then describe the arch of a circle from that perpendicular, to break in fair with the lower side of the rail in the middle, and also another from the beak-head perpendicular, to break in fair with the upper side of the rail at the middle, observing to continue the head of it sufficiently high to range with the timber heads above the forecastle.

The head timbers are next to be drawn, placing the stem timber its own thickness abaft the stem, and the foremost must be so placed that the fore side may be up and down with the heel of the block or figure, which has not yet been set off. Take therefore the distance from the breast to the heel on a square which is seven feet, and erect a perpendicular from the lower part of the lower cheek to the lower part of the upper cheek; which perpendicular will terminate the foremost end of the lower cheek and the heel of the figure, and will also terminate the lower end of the hair-bracket: then, by continuing the same perpendicular from the upper part of the

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the lower-deck to the under part of the main-rail, the fore ſide of the foremoſt head timber will be deſcribed; and by ſetting off its thickneſs aft, the other ſide may be drawn. The middle head timber may be ſpaced between the two former ones; and there may alſo be one timber placed abaft the ſtem, at a diſtance from the ſtem, equal to that between the others, and the lower end of it may ſtep on the upper edge of the lower rail.

To deſcribe the middle and lower rails, divide the diſtance between the lower part of the main rail and the upper part of the upper cheek equally at every head timber; and curves being deſcribed through theſe points will form the middle and lower rails. The after end of the lower rail muſt terminate at the after edge of the after head timber.

The cat-head ought to be repreſented in ſuch a manner as to come againſt the aft ſide of the head of the main rail, to rake forward four inches in a foot, and to ſteeve up $5\frac{1}{2}$ inches in a foot, and about one foot ſix inches ſquare. The lower part of it comes on the plank of the deck at the ſide, and the ſupporter under it muſt form a fair curve to break in with the after end of the middle rail.

The hawſe holes muſt come between the cheeks, which is the moſt convenient place for them; but their place fore and aft cannot be exactly determined until they are laid down in the half-breadth plan.

The knee of the head is to project from the breaſt of the figure about two inches; and particular care muſt be taken that in forming it downwards it be not too full, as it is then liable to rub the cable very much: it may therefore have no more ſubſtance under the lower cheek at the heel of the figure than is juſt ſufficient to admit of the bobſtay holes, and may be $3\frac{1}{2}$ feet diſtant from the ſtem at the load water-line, making it run in an agreeable ſerpentine line from the breaſt down to the third water line, where it may be $1\frac{1}{2}$ feet from the ſtem. By continuing the ſame line downwards, keeping it more diſtant from the ſtem as it comes down, the *gripe* will be formed. The lower part of it muſt break in fair with the under part of the falſe keel; and the breadth of the gripe at the broadeſt place will be found by the proportions to be $4\frac{1}{2}$ feet. As the aft part of the gripe is terminated by the fore foot, or foremoſt end of the keel, it will now be proper to finiſh that part as follows: From the line repreſenting the upper edge of the keel ſet down the depth of the keel, through which draw a line parallel to the former, and it will be the lower edge of the keel. From that point, where the aft ſide of the ſtem is diſtant from the upper edge of the keel by a quantity equal to the breadth of the keel at midſhips, erect a perpendicular, which will limit the foremoſt end of the keel; and the after or lower end of the ſtem may be repreſented by ſetting off the length of the ſcarf from the foremoſt end of the keel, which may be ſix feet. Set down from the line repreſenting the lower edge of the keel the thickneſs of the falſe keel, which is ſeven inches; and a line drawn through that point parallel to the lower edge of the keel will be the under edge of the falſe keel, the foremoſt end of which may be three inches afore the foremoſt end of the main keel.

The head being now finiſhed, proceed next to the ſtern, the ſide and middle timbers of which are already drawn. From the ſide timber ſet off forward 14 feet, the length of gallery, and draw a pencil line parallel to the ſide timber; draw alſo a line to interſect the touch of the upper counter at the ſide, producing it forwards parallel to the ſheer as far as the pencil line firſt drawn; and this line will repreſent the upper edge of the gallery rim. From which ſet down eight inches, the breadth of the gallery rail, and draw the lower edge of the rail. At the diſtance of eight inches from the fore ſide of the ſide timber draw a line parallel thereto; and from the point of interſection of this line with the upper edge of the gallery rim, draw a curve to the middle timber parallel to the touches of the upper counter, which line will repreſent the upper edge of the upper counter rail as it appears on the ſheer draught. The lower edge of this rail may be formed by ſetting off its depth from the upper edge. In the ſame manner the lower counter rail may be deſcribed: then take the diſtance between that and the upper counter rail, and ſet it off below the rim rail; and hence the rail that comes to the lower ſtool may be drawn, keeping it parallel to the rim rail. Underneath that, the lower finiſhing may be formed, making it as light and agreeable as poſſible.

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Set off from the middle timber on the end of the quarter-deck the projection of the balcony, which may be about two feet, and draw a line with a pencil parallel to the middle timber. On this line ſet off a point $1\frac{1}{2}$ inches below the under ſide of the quarter-deck, from which draw a curve to the ſide timber parallel to the upper counter rail, which curve will repreſent the lower ſide of the foot ſpace rail of the balcony as it appears in the ſheer draught.

Take the diſtance between the point of interſection of the upper edge of the upper counter with the middle line, and the point of interſection of the under ſide of the foot ſpace rail with the middle line, which ſet up on a perpendicular from the upper edge of the rim rail at the foremoſt end. Through this point draw a line parallel to the rim rail to interſect the lower part of the foot ſpace rail, and this line will repreſent the lower edge of the rail that comes to the middle ſtool, and will anſwer to the foot ſpace rail. Then between this line and the rim rail three lights or ſaſhes may be drawn, having a muntin or pillar between each light of about 14 inches broad, and the lower gallery will be finiſhed. Set off the depth of the middle ſtool rail above the line already drawn for the lower edge, and the upper edge may be drawn. Then ſet off the ſame depth above the curve drawn for the lower edge of the foot ſpace rail, and the upper edge of that rail may then be drawn.

The quarter-piece muſt be next deſcribed, the heel of which muſt ſtep on the after end of the middle ſtool. Draw a line with a pencil parallel to the middle timber, and at a diſtance therefrom, equal to the projection of the balcony. Upon this line ſet up from the roundhouſe deck the height of the upper part of the ſtern or taff rail, which may be four feet above the deck. At that height draw with a pencil a horizontal line, and from its interſection with the line firſt drawn deſcribe a curve to the middle ſtool rail, obſerving to make the lower part of this curve run nearly parallel to the ſide timber, and the lower part about three inches abaft the ſide timber; and this curve will repreſent the aft ſide of the quarter-piece at the outſide. There ſet off the thick-

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nefs of the quarter-piece, which is one foot fix inches, afore the curve already drawn; and another curve being defcribed parallel to it from the lower part to the top of the fheer, and the quarter-piece at the outfide will be reprefented. On the horizontal line drawn for the upper part of the taff-rail fet off forward the thicknefs of the taff-rail, which is one foot; then draw a curve down to the head of the quarter-piece parallel to the firft, and that part of the taff-rail will be defcribed. Inftead of a fair curve, it is cuftomary to form the upper part of the taff-rail with one or two breaks, and their curves inverted. Either way may, however, be ufed according to fancy.

Set off the depth of the taff-rail, which may be about 3½ feet, on the line drawn for the projection; from the upper part, and from this point, defcribe a curve as low as the heel of the quarter-piece, and about five inches abaft it at that place; obferving to make it run nearly parallel to the after edge of the quarter-piece; and the after part of the quarter-piece, which comes neareft to the fide, will be reprefented.

Set up on the line drawn for the projection of the balcony the height of the upper part of the balcony or breaft rail, which is 3½ feet from the deck; fet off the thicknefs of the rail below that, and defcribe the balcony, keeping it parallel to the foot fpace rail, and terminating it at the line drawn for the after part of the quarter-piece neareft the fide; and the whole balcony will then be reprefented.

The upper gallery is then to be defcribed. In order to this, its length muft be determined, which may be 11 feet. Set off this diftance from the fide timber forward with the fheer; and at this point draw a line parallel to the fide timber, which line will reprefent the fore part of the gallery. Then take the diftance between the upper part of the foot fpace rail and the upper part of the breaft rail on a perpendicular, and fet it off on a perpendicular from the upper part of the middle ftool rail on the line drawn for the fore part of the gallery, from which to the fore part of the quarter-piece draw a ftraight line parallel to the rail below, which line will be the upper edge of the upper rim rail; and its thicknefs being fet off, the lower edge may alfo be drawn. From the upper edge of that rail fet up an extent equal to the diftance between the lower rim rail and middle ftool rail, and defcribe the upper ftool rail, the after end of which will be determined by the quarter-piece, and the fore end by the line for the length of the gallery. There may be three fafhes drawn between thefe two rails as before; and hence the upper gallery will be formed.

The upper finifhing fhould be next drawn, the length of which may be 1½ foot lefs than the upper gallery. Draw a line parallel to the rake of the ftern for the fore end of it, and let the upper part of the top fide be the upper part of the upper rail, from which fet down three inches for the thicknefs of the rail, and defcribe it. Defcribe alfo another rail of the fame length and thicknefs as the former, and eight inches below; from the end of which a ferpentine line may be drawn down to the upper ftool rail, and the upper finifhing will be completed.

The ftern being now finifhed, the rudder only remains to be drawn. The breadth of the rudder at the lower part is to be determined from the proportions, and fet off from the line reprefenting the aft part of the ftern-poft; which line alfo reprefents the fore part of the rudder. Then determine on the lower hance, letting it be no higher than is juft fufficient, which may be about one foot above the load water-line, and fet off its breadth at that place taken from the proportions. Then a line draw from thence to the breadth fet off at the lower part will be the aft fide of the rudder below the lower hance. There may alfo be another hance about the height of the lower deck. The ufe of thefe breaks or hances is to reduce the breadth as it rifes toward the head. The aft part may be drawn above the lower hance, the break at the lower hance being about ten inches, and the break at the upper hance fix inches.—The back may be then drawn. It is of elm, about four inches thick on the aft part. That thicknefs being fet off, and a line drawn from the lower hance to the lower end, will reprefent the back. The head of the rudder fhould be as high as to receive a tiller above the upper deck. Therefore fet off the fize of the head above the upper deck, and draw a line from thence to the break at the upper hance, and the aft part of the rudder will be reprefented all the way up. The bearding fhould be drawn, by fetting off the breadth of it at the keel from the fore fide of the rudder, which may be nine inches. Set off alfo the breadth at the head of the wing tranfom, which may be a foot. Then a line being drawn through thefe two points, from the lower part of the rudder to about a foot above the wing tranfom, and the bearding will be reprefented. As the bearding is a very nice point, and the working of the rudder depending very much upon it, it fhould always be very particularly confidered. It has been cuftomary to beard the rudder to a fharp edge at the middle line, by which the main piece is reduced more than neceffary. The rudder fhould, however, be bearded from the fide of the pintles, and the fore fide made to the form of the pintles.

The pintles and braces may next be drawn. In order to which determine the place of the upper one, which muft be fo difpofed that the ftraps fhall come round the head of the ftandard, which is againft the head of the ftern-poft on the gun-deck, and meet at the middle line. By this means there is double fecurity both to the brace and ftandard. To obtain thofe advantages, it muft therefore be placed about four inches above the wing tranfom: the fecond muft be placed juft below the gun-deck fo as to bolt in the middle of the deck tranfom, and the reft may be fpaced equally between the lower one, which may be about fix inches above the upper edge of the keel. The number of them is generally feven pair upon this clafs of fhips; but the number may be regulated by the diftance between the fecond and upper one, making the diftance between the reft nearly the fame. The length of all the braces will be found by fetting off the length of the lower one, which may be eight feet afore the back of the ftern-poft, and alfo the length of the third, which is four feet and a half afore the back of the ftern-poft; and a line drawn from the one extremity to the other will limit the intermediate ones, as will appear on the fheer draught. The braces will feem to diminifh in length very much as they go up; but when meafured or viewed on the fhape of the body, they will be nearly of an equal length. The length of the ftraps of the pintles which

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come upon the rudder may all be within four inches of the aft side of the rudder; and the rudder being a flat surface, they will all appear of the proper lengths.

II. *Of the half-breadth and body plans.*—The half-breadth plan must be first drawn. Then produce the lower edge of the keel both ways, and let it also represent the middle line of the half-breadth plan. Produce all the frames downwards, and also the fore and after perpendiculars. Then from the place in the sheer-plan, where the height of breadth-lines intersect the stem, square down to the middle line the fore and aft part of the rabbet and the fore part of the stem. Take from the dimensions what the stem is sided at that place, and set off half of it from the middle line in the half-breadth plan, through which draw a line parallel to the middle line through the three lines squared down, and the half breadth of the stem will be represented in the half-breadth plan. Take the thickness of the plank of the bottom which is $4\frac{1}{2}$ inches, and describe the rabbet of the stem in the half-breadth plan.

From the points of intersection of the height of breadth lines with the counter timber at the side, and with the counter timber at the middle line, draw lines perpendicular to the middle line of the half-breadth plan, from which set off the half breadth of the counter on the line first drawn; and from this point to the intersection of the line last drawn, with the middle line draw a curve, and the half breadth of the counter will be represented at the height of breadth, which will be the broadest part of the stern.

Take the main half breadth of timber dead flat from the dimensions, and lay it off from the middle line on dead flat in the half-breadth plan. Take also from the dimensions the main half breadth of every timber, and set off each from the middle line on the corresponding timbers in the half-breadth plan. Then a curve drawn from the end of the line representing the half breadth of the counter through all the points, set off on the timbers, and terminating at the aft part of the stern, will be the main half-breadth line. Take from the dimensions the top-timber half breadth, and describe the top-timber half-breadth line in the half-breadth plan, in the same manner as the main half-breadth line.

Take from the dimensions the half breadth of the rising, and set it off from the middle line on the corresponding timbers in the half-breadth plan, observing, where the word *outside* is expressed in the tables, the half breadth for that timber must be set off above or on the outside of the middle line. Then a curve drawn through these points will be the half breadth of rising in the half-breadth plan.

Plate CCCCXCII. Fig. 35.

It will now be necessary to proceed to the body plan. Draw a horizontal line (fig. 35.), which is called the *base line*, from the right hand extremity of which erect a perpendicular. Then set off on the base line the main half breadth at dead flat, and erect another perpendicular, and from that set off the main half breadth again, and erect a third perpendicular. The first perpendicular, as already observed, is called the side line of the fore body; the second the middle line; and the third the side line of the after body.

Take from the dimensions the heights of the diagonals up the middle line, and set them from the base up the middle line in the body plan. Take also their distances from the middle line on the base, and set them off. Set off also their heights up the side lines, and draw the diagonals. Then take from the sheer plan the heights of the lower height of breadth line, and set them off upon the middle line in the body plan; through these points lines are to be drawn parallel to the base, and terminating at the side lines. In like manner proceed with the upper height of breadth line.

The rising is next to be set off on the body plan; it must, however, be first described in the sheer plan: Take, therefore, the heights from the dimensions, and set them off on the corresponding timbers in the sheer plan, and a curve described through these points will be the rising line in the sheer plan. Then take from the dimensions the rising heights of dead flat. Set it off in the body plan, and draw a horizontal line. Now take all the rising heights from the sheer plan, and set them off in the body plan from the line drawn for the rising height of dead flat, and draw horizontal lines through these points. Take from the half-breadth plan the half breadths of the rising, and set them off from the middle line in the body plan, and the centres of the floor sweeps of the corresponding timbers will be obtained.

From the half-breadth plan take the main half-breadth lines, and set them off from the middle line in the body plan on the corresponding lines before drawn for the lower height of breadth; and from the extremities of these lines set off towards the middle line the lengths of the lower breadth sweeps respectively.

Take from the dimensions the distance of each frame from the middle line on the diagonals, and set them off from the middle line on their respective diagonal lines. Now these distances being set off, and the lower breadth and floor sweeps described, the shape of the frames below the breadth line may easily be drawn as follows: Place one point of a compass in the distance set off for the length of the lower breadth sweep, and extend the other to the point which terminates the breadth, and describe an arch of a circle downwards, which will intersect the points set off on the upper diagonal lines, letting it pass as low as convenient. Then fix one point of the compasses in the centre of the floor sweep, and extend the other to the point set off on the fourth diagonal, which is the floor head; and describe a circle to intersect as many of the points set off on the diagonals as it will. Then draw a curve from the back of the lower breadth sweep, through the points on the diagonals, to the back of the floor sweep. Describe also another curve from the back of the floor sweep through the points on the lower diagonals, and terminating at the upper part of the rabbet of the keel, and that part of the frame below the breadth will be formed. In like manner describe the other frames.

Through the extremities of the frames at the lower height of breadth draw lines parallel to the middle line, and terminating at the upper height of breadth line, and from thence set off the upper breadth sweeps; now fix one point of the compass in the centres of the upper breadth sweeps successively, and the other point to the extremities of the frames, and describe circles upwards. Then from the sheer plan take off the heights of the top-timber lines, and set them off in the body plan, drawing horizontal lines; upon which set off the top-timber half breadths taken from the corresponding timbers

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bers in the half-breadth plan; and by describing curves from the back of the upper breadth sweeps through the points set off on the seventh or upper diagonal; and intersecting the top-timber half-breadths, the timbers will then be formed from the keel to the top of the side. The upper end of the timbers may be determined by taking the several heights of the upper part of the top side above the top-timber line, and setting them off above the top-timber line on the corresponding timbers in the body plan. The lower parts of the timbers are ended at the rabbet of the keel as follows: With an extent of four inches and a half, the thickness of the bottom, and one leg of the compasses at the place where the line for the thickness of the keel intersects the base line; with the other leg describe an arch to intersect the keel line and the base. Then fix one point at the intersection of the arch and keel, and from the point of intersection of the keel and base describe another arch to intersect the former. Then from the intersection of these arches draw one straight line to the intersection of the keel and base, and another to the intersection of the lower arch and the keel, and the rabbet of the keel will be described at the main frame. All the timbers in the middle part of the ship which have no rising terminate at the intersection of the upper edge of the rabbet with the base line; but the lower part of the timbers, having a rising, end in the centre of the rabbet, that is, where the two circles intersect. Those timbers which are near the after end of the keel must be ended by setting off the half breadth of the keel at the port in the half-breadth plan, and describe the tapering of the keel. Then at the corresponding timbers take off the half breadth of the keel; set it off in the body plan, and describe the rabbet as before, letting every timber end where the two circles for its respective rabbet intersect.

To describe the side counter or stern timber, take the height of the wing transom, the lower counter, upper counter, and top-timber line at the side; from the sheer plan transfer them to the body plan, and through these points draw horizontal lines. Divide the distance between the wing transom and lower counter into three equal parts, and through the two points of division draw two horizontal lines. Draw also a horizontal line equidistant from the upper counter and the top-timber line in the sheer plan, and transfer them to the body plan.

Now, from the point of intersection of the aft side of the stern timber at the side, with the wing transom at the side in the sheer plan, draw a line perpendicular to the middle line in the half-breadth plan. Draw also perpendicular lines from the points where the upper and lower transoms touch the stern-post; from the points of intersection of the stern timber with the two horizontal lines drawn between, and from the intersection of the stern timber with the horizontal line drawn between the upper counter and top-timber line. Then curves must be formed in the half-breadth plan for the shape of the body at each of these heights. In order to which, begin with the horizontal or level line representing the height of the wing transom in the body plan. Lay a slip of paper to that line, and mark on it the middle line and the timbers 37, 35, 33, and 29; transfer the slip to the half-breadth plan, placing the point marked on it for the middle line exactly on the middle in the half-breadth plan, and set off the half breadths on the corresponding timbers 37, 35, 33, and 29, and describe a curve through these points, and to intersect the perpendicular drawn from the sheer plan. In like manner proceed with the horizontal lines at the heights of the counters, between the lower counter and wing transom, above the upper counter and top-timber line; and from the intersections of the curve drawn in the half-breadth plan, with the perpendicular lines drawn from the sheer plan, take the distances to the middle line, and set them off on the corresponding lines in the body plan; then a curve described through the several points thus set off will be the representative of the stern timber.

The round-up of the wing transom, upper and lower counter, may be taken from the sheer draught, and set off at the middle line above their respective level lines in the body plan, by which the round-up of each may be drawn. The round aft of the wing transom may also be taken from the sheer plan, and set off at the middle line, abaft the perpendicular for the wing transom in the half-breadth plan, whence the round aft of the wing transom may be described.

The after body being now finished, it remains to form the fore body; but as the operation is nearly the same in both, a repetition is therefore unnecessary, except in those parts which require a different process.

The foremost timbers end on the stem, and consequently the method of describing the ending of them differs from that used for the timbers used in the after body. Draw a line in the body plan parallel to the middle line, at a distance equal to the half of what the stem is sided. In the sheer plan take the height of the point of intersection of the lower part of the rabbet of the stem with the timber which is required to be ended, and set it off on the line before drawn in the body plan. Then take the extent between the points of intersection of the timber with the lower and upper parts of the rabbet, and with one leg of the compasses at the extremity of the distance laid off in the body plan describe a circle, and the timbers may then pass over the back of this circle. Now, by applying a small square to the timber, and letting the back of it intersect the point set off for the lower part of the rabbet, the lower part of the rabbet and the ending of the timbers will be described.

The foremost timbers differ also very much at the head from those in the after body: For since the ship carries her breadth so far forward at the top-timber line, it therefore occasions the two foremost frames to fall out at the head beyond the breadth, whence they are called *knuckle* timbers. They are thus described: The height of the top-timber line being set off in the body plan, set off on it the top half breadth taken from the half-breadth plan, and at that place draw a perpendicular; then from the sheer plan take the height of the top of the side, and set it off on the perpendicular in the body plan: Take also the breadth of the rail at the top-timber line in the sheer plan, and set it off below the top-timber line at the perpendicular line in the body plan, and the straight part of the knuckle timber to be drawn will be determined. Then from the last-mentioned point set off describe a curve through the points set off for the timber down to the upper breadth, and the whole knuckle timber will be formed. It will hence be feen that thofe timbers forward will fall out beyond the main breadth with a hollow, contrary to the reft of the top fide, which falls within the main breadth with a hollow.

The fore and after bodies being now formed, the water lines muft next be defcribed in the half-breadth plan, in order to prove the fairnefs of the bodies. In this draught the water lines are all reprefented parallel to the keel; their heights may, therefore, be taken from the fheer plan, and transferred to the body plan, drawing horizontal lines, and the water lines will be reprefented in the body plan. In fhips that draw more water abaft than afore, the water lines will not be parallel to the keel; in this cafe, the heights muft be taken at every timber in the fheer plan, and fet off on their correfponding timbers in the body plan; and curves being defcribed through the feveral points, will reprefent the water lines in the body plan.

Take the diftances from the middle line to the points where the water lines interfect the different timbers in the body plan, and fet them off on their correfponding timbers in the half-breadth plan. From the points where the water lines in the fheer plan interfect the aft part of the rabbet of the fternpoft draw perpendiculars to the middle line of the half-breadth plan, and upon thefe perpendiculars fet off from the middle line the half thicknefs of the fternpoft at its correfponding water line; which may be taken from the body plan, by fetting off the fize of the poft at the head and the keel, and drawing a line for the tapering of it; and where the line fo drawn interfects the water lines, that will be the half thicknefs required: then take an extent in the compaffes equal to the thicknefs of the plank, and fix one point where the half thicknefs of the poft interfects the perpendicular, and with the other defcribe a circle, from the back of which the water lines may pafs through their refpective points fet off, and end at the fore part of the half-breadth plan, proceeding in the fame manner as with the after part. A line drawn from the water line to the point fet off for the half thicknefs of the poft will reprefent the aft part of the rabbet of the poft; and in like manner the rabbet of the ftem may be reprefented. The water lines being all defcribed, it will be feen if the body is fair; and if the timbers require any alteration, it fhould be complied with.

The cant-timbers of the after body may next be defcribed in the half-breadth plan; in order to which the cant of the fafhion-piece muft firft be reprefented. Having therefore the round aft of the wing tranfom reprefented in the half-breadth plan, and alfo the fhape of a level line at the height of the wing tranfom; then fet off the breadth of the wing tranfom at the end, which is one foot four inches, and that will be the place where the head of the fafhion-piece will come: now to determine the cant of it, the fhape of the body muft be confidered; as it muft be canted in fuch a manner as to preferve as great a ftraightnefs as is poffible for the fhape of the timber, by which means the timber will be much ftronger than if it were crooked; the cant muft alfo be confidered, in order to let the timber have as little bevelling as poffible. Let, therefore, the heel of the timber be fet off on the middle line, two feet afore timber 35; and then drawing a line from thence to the point fet off on the level line for the wing tranfom, the cant of the fafhion-piece will be defcribed, and will be found fituated in the beft manner poffible to anfwer the before mentioned purpofes.

The cant of the fafhion-piece being reprefented, the cant of the other timbers may now be eafily determined. Let timber 29 be the foremoft cant timber in the after body, and with a pencil draw timber 28; then obferve how many frames there are between timber 28 and the fafhion-piece, which will be found to be nine, namely, 29, 30, 31, 32, 33, 34, 35, 36, and 37. Now divide the diftance between timber 28 and the fafhion-piece on the middle line into 10 equal parts: Divide alfo the correfponding portion of the main half-breadth lines into the fame number of equal parts; and ftraight lines joining the correfponding points at the middle line with thofe in the half-breadth line will reprefent the cant timbers in the after body.

The line drawn for the cant of the fafhion-piece reprefents the aft fide of it, which comes to the end of the tranfoms; but in order to help the converfion with regard to the lower tranfoms, there may be two more fafhion-pieces abaft the former; therefore the foremoft fafhion-piece, or that which is already defcribed in the half-breadth plan, may only take the ends of the three upper tranfoms, which are, the wing, filling, and deck: the middle fafhion-piece may take the four next, and the after fafhion-piece the lower ones: therefore fet off in the half-breadth plan the fiding of the middle and after fafhion-piece, which may be 13 inches each; then by drawing lines parallel to the foremoft fafhion-piece, at the aforefaid diftance from each other, the middle and after fafhion-piece will be reprefented in the half-breadth plan.

The fafhion-piece and tranfoms yet remain to be reprefented in the fheer plan; in order to which, let the number of tranfoms be determined, which, for fo large a buttock, may be feven below the deck tranfom: draw them with a pencil, beginning with the wing, the upper fide of which is reprefented by a level line at its height; fet off its fiding below that, and draw a level line for the lower edge. The filling tranfom follows; which is merely for the purpofe of filling the vacancy between the under edge of the wing and the upper part of the deck plank: it may therefore be reprefented by drawing two level lines for the upper and lower edge, leaving about two inches between the upper edge and lower edge of the wing tranfom, and four inches between the lower edge of the gun-deck plank; then the deck tranfom muft be governed by the gun-deck, letting the under fide of the gun-deck plank reprefent the upper fide of it, and fetting off its fiding below that; the under edge may alfo be drawn: the tranfoms below the deck may all be fided equally, which may be 11 inches; they muft alfo have a fufficient diftance between to admit the circulation of the air to preferve them, which may be about three inches.

The tranfoms being now drawn with a pencil, the fafhion-piece muft next be defcribed in the fheer plan, by which the length of the tranfoms as they appear in that plan will be determined. As the foremoft fafhion-piece reaches above the upper tranfom, it may therefore be firft defcribed: in order to which, draw a fufficient number of level lines in the fheer plan; or, as the water lines are level, draw therefore one line between the upper water line and the wing tranfom, and one above the

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the wing tranfom at the intended height of the head of the fafhion-piece, which may be about five feet: then take the height of thefe two level lines, and transfer them to the body plan; and take off two or three timbers and run them in the half-breadth plan, in the fame manner as the water lines were done; then from the point where the line drawn for the cant of the fafhion-piece, in the half-breadth plan, interfects the level line drawn for the head of the fafhion-piece, draw up a perpendicular to the faid line in the fheer plan, making a point. Again, from the interfection of the cant line, with the level line for the wing tranfom in the half-breadth plan, draw a perpendicular to the wing tranfom in the fheer plan. Alfo draw perpendiculars from the points where the cant line in the half-breadth plan interfects the level line below the wing tranfom, and alfo the water lines to the correfponding lines in the fheer plan; then a curve defcribed through thefe points will be the reprefentation of the foremoft fafhion-piece in the fheer plan. In the fame manner the middle and after fafhion-pieces may be defcribed; obferving to let the middle one run up no higher than the under part of the deck tranfom, and the after to the under fide of the fourth tranfom under the deck. The tranfoms may now be drawn with ink, as their lengths are limited by the fafhion-pieces.

Neither the head nor the forefide of the fternpoft are yet defcribed; take, therefore, from the dimenfions, the breadth of the poft on the keel, and fet it off on the upper edge of the keel from the aft fide of poft. The head of the poft muft next be determined, which muft juft be high enough to admit of the helm-poft tranfom and the tiller coming between it and the upper deck beam; the height therefore that is neceffary will be one foot nine inches above the wing tranfom. Now draw a level line at that height, upon which fet off the breadth of the fternpoft at that place, taken from the dimenfions, and a line drawn from thence to the point fet off on the keel will be the forefide of the fternpoft; obferving, however, not to draw the line through the tranfoms, as it will only appear between them. The inner poft may be drawn, by fetting off its thicknefs forward from the fternpoft, and drawing a ftraight line as before, continuing it no higher than the under fide of the wing tranfom.

The cant timbers in the after body being defcribed, together with the parts dependent on them, thofe in the fore body may be next formed; in order to which, the foremoft and aftermoft cant timbers muft be firft determined, and alfo the cant of the foremoft ones. The foremoft cant timber will extend fo far forward as to be named *&*; the cant on the middle line may be one foot four inches afore fquare timber W, and on the main half breadth line one foot nine inches afore timber Y; in which fituation the line may be drawn for the cant; the aftermoft may be timber Q. The cant timbers may now be defcribed in the fame manner as thofe in the after body, namely, by fpacing them equally between the cant timber *&* and the fquare timber P, both on the main half-breadth, and middle lines, and drawing ftraight lines between the correfponding points, obferving to let them run out to the top-timber half-breadth line, where it comes without the main half-breadth line.

The hawfe pieces muft next be laid down in the half-breadth plan; the fides of which muft look fore and aft with the fhip upon account of the round of the bow. Take the fiding of the apron, which may be about four inches more than the ftem, and fet off half of it from the middle line, drawing a line from the main half-breadth to the foremoft cant timber, which will reprefent the foremoft edge of the knight-head; then from that fet off the fiding of the knight-head, which may be one foot four inches, and draw the aft fide of it. The hawfe pieces may then be drawn, which are four in number, by fetting off their fidings, namely, one foot fix inches parallel from the knight-head and from each other; and ftraight lines being drawn from the main half-breadth line to the foremoft cant timber will reprefent them.

The hawfe holes fhould be defcribed in fuch a manner as to wound the hawfe pieces as little as poffible; they may therefore be placed fo that the joint of the hawfe pieces fhall be in the centre of the holes, whence they will only cut half the hawfe pieces. Take the dimenfions of the hawfe holes, which is one foot fix inches, and fet off the foremoft one, or that next the middle line, on the joint between the firft and fecond hawfe piece; then fet off the other on the joint between the third and fourth hawfe piece; and fmall lines being drawn acrofs the main half-breadth at their refpective places will reprefent the hawfe holes in the half-breadth plan.

The hawfe holes fhould next be reprefented in the fheer plan. In this clafs of fhips they are always placed in the middle between the cheeks; therefore fet off their diameter, namely, one foot fix inches, between the cheeks, and draw lines parallel to the cheeks for their upper and lower part. Then to determine their fituation agreeable to the half-breadth plan, which is the fore and aft way, draw perpendiculars from their interfections with the main half-breadth line to the lines drawn between the cheeks, and their true fituations, the fore and aft way, will be obtained; and, by defcribing them round or circular, according to the points fet off, they will be reprefented as they appear in the fheer plan.

The apron may be drawn in the fheer plan, fetting off its bignefs from the ftem, and letting it come fo low that the fcarf may be about two feet higher than the foremoft end of the fore foot; by which it will give fhip to the fcarfs of the ftem. It may run up to the head of the ftem.

The cutting down fhould next be drawn. Take therefore from the tables of dimenfions the different heights there expreffed, and fet them off from the upper edge of the keel on the correfponding timbers in the fheer plan: then a curve defcribed through the points fet off, from the inner poft aft to the apron forward, will be the cutting down. Next fet off from the cutting down the thicknefs of the timber ftrake, which is eight inches and a half, and a curve defcribed parallel to the former will reprefent the timber ftrake, from which the depth of the hold is always meafured.

The kelfon is drawn, by taking its depth from the dimenfions, and fet it off above the cutting down line; and a curve defcribed parallel to the cutting down will reprefent the kelfon.

The cutting down line being defcribed, the knee of the dead wood abaft timber 27, being the after floor timber, may then be reprefented. Set off the fiding of the floor abaft it, and erect a perpendicular in the fheer plan, which will terminate the foremoft end of the

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the dead wood: then the fore and aft arm of the knee may be half the length of the whole dead wood, and the up and down arm may reach to the under part of the lower tranſom; and the whole knee may be placed in ſuch a manner that the upper piece of the dead wood ſhall bolt over it, and be of as much ſubſtance as the knee itſelf: therefore the knee muſt conſequently be placed its whole thickneſs below the cutting down line repreſenting the upper part of the dead wood.

The ſheer draught, the body, and half-breadth pl are now finiſhed, from whence the ſhip may be laid down in the mould loft, and alſo the whole frame erected. As, however, the uſe of the diagonal lines in the body plan has not been ſufficiently explained, it is therefore thought proper to ſubjoin the following illuſtration of them.

45 Nature and uſe of diagonal lines.

The diagonal lines in the body plan are mentioned in the tables of dimenſions merely for the purpoſe of forming the body therefrom; but after the body is formed, they are of very principal uſe, as at their ſtations the ribbands and harpins which keep the body of the ſhip together while in her frames are all deſcribed, and the heads of the different timbers in the frame likewiſe determined.

The lowermoſt diagonal, or N° 1. which is named the *lower ſirmark*, at which place the bevellings are taken for the hollow of the floors; its ſituation is generally in the middle between the keel and the floor ſirmark.

Second diagonal is placed in the midſhips, about 18 inches below the floor head, and is the ſtation where the floor ribband is placed in midſhips, and likewiſe the floor harpin forward; there is alſo a bevelling taken at this diagonal all the way fore and aft, from which it is termed the *floor ſirmark*.

Third diagonal, terminates the length of the floors, and is therefore called the *floor head*. There are likewiſe bevellings taken at this diagonal as far forward and aft as the floor extends. The placing of this diagonal is of the utmoſt conſequence to the ſtrength of the ſhip, it being ſo near to that part of the bulge which takes the ground, and of conſequence is always liable to the greateſt ſtrain: it ſhould therefore be placed as much above the bearing of the body in midſhips as could be conveniently allowed by converſion of the timber; but afore and abaft it is not of ſo much conſequence.

Fourth diagonal is placed in the middle between the floor head and the fifth diagonal, at which place a ribband and harpin are ſtationed for the ſecurity of the firſt or lower futtock, from whence it is named the *firſt futtock ſirmark*. There are alſo bevellings taken at this diagonal all afore and aft, which being part of the body where the timbers moſt vary, occaſions them to be the greateſt bevellings in the whole body.

Fifth diagonal terminates the heads of the firſt futtocks, and is therefore called the *firſt futtock head*. It ſhould be placed at a convenient diſtance above the floor head, in order to give a ſufficient ſcarf to the lower part of the ſecond futtocks. There are likewiſe bevellings for the timbers taken at this diagonal, all fore and aft.

Sixth diagonal ſhould be placed in the middle between the firſt futtock head and the ſeventh diagonal; at which place the ribband and harpin are ſtationed for the ſupport of the ſecond futtocks. Bevellings are taken at this diagonal all fore and aft. It is named the *ſecond futtock ſirmark*.

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Seventh diagonal terminates the ſecond futtock heads from the fore to the aftermoſt floors, and afore and abaft them it terminates the double futtock heads in the fore and aft cant bodies. It ſhould be placed in midſhips, as much above the firſt futtock head as the firſt futtock is above the floor head: by which it gives the ſame ſcarf to the lower part of the third futtock as the firſt futtock does to the ſecond. There are bevellings taken all fore and aft at this diagonal. It is named the *ſecond futtock head*.

Eighth diagonal is the ſtation for the ribband and harpin which ſupports the third futtocks, and is therefore placed between the ſecond futtock head and ninth diagonal. It is alſo a bevelling place, and is named the *third futtock ſirmark*.

Ninth and laſt diagonal is placed the ſame diſtance above the ſecond futtock head as that is above the firſt, and terminates all the heads of the third futtocks which are in the frames, as they come between the ports; but ſuch as are between the frames, and come under the lower deck ports, muſt run up to the under part of the ports, as no ſhort timbers ſhould by any means be admitted under the ports, which require the greateſt poſſible ſtrength. This diagonal is likewiſe a bevelling place for the heads of the third futtocks, and is therefore called the *third futtock head*.

The fourth futtock heads are terminated by the under part of the upper deck ports all fore and aft, and a ribband is placed fore and aft at the height of the upper breadth line, another between the lower and upper deck ports, and one at the top-timber line; which, with the ribbands and harpins before mentioned, keep the whole body of the ſhip together, and likewiſe in its proper form and ſhape.

It muſt be obſerved, that the diagonal lines laid down in the dimenſions will not correſpond to what has been ſaid above upon diagonals, as they were drawn diſcretionally upon the body for the purpoſe of giving the true dimenſions of it. Therefore, when the body is drawn in fair, the firſt diagonals (which ſhould only be in pencil) are to be rubbed out, and the proper diagonals drawn with red ink, ſtrictly adhering to what has been ſaid above.

Sect. III. *Of the Inboard Works of the Ship deſcribed in the preceding Section.*

Draughts of the outboard works being now conſtructed, in which every part is deſcribed that is neceſſary to enable the artiſt to put the ſhip in her frames, we muſt now proceed to form another draught of the cavity of the ſhip or inboard works, which muſt be ſo contrived that every thing within the ſhip may be arranged in the moſt commodious manner and to the beſt advantage.

It is uſual to draw the inboard works in the ſheer-draught; but as this generally occaſions much confuſion, it is therefore the beſt and eaſieſt method to appropriate a draught to this particular purpoſe. *Ship-Builder's Repoſitory.*

Take from the ſheer-draught the ſtem, ſtern-poſt, counter timbers, and keel, and deſcribe them on another paper; draw in alſo the cutting down, kelſon, apron, tranſoms, faſhion-pieces, and decks, and the upper line of the ſheer all fore and aft, alſo paſs the timbers and ports.

The

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The beams come first under consideration, and should be so disposed as to come one under and one between each port, or as near as can be to answer other works of the ship; but where it happens that a beam cannot possibly be placed under the port, then a beam arm should be introduced to make good the deficiency. Every beam, and also the beam arms, should be kneed at each end with one lodging and one hanging knee; and in those parts of the ship which require the knees to be very acute, such as the after beams of the gun-deck, and in some ships, whose bodies are very sharp, the foremost beams of the gun-deck, there should be knees of iron. Care should be taken always to let the upper side of the knees be below the surface of the beams, in large ships one inch and a half, and in small ships an inch, by which means the air will have a free passage between the knees and under part of the deck.

In the conversion of the beams the side next the lodging knee should be left as broad at the end of the beam as can possibly be allowed by the timber, the beam retaining its proper scantling at the end of the lodging knee: by so doing the lodging knees will be more without a square, which consequently makes them the more easy to be provided.

In ships where the beams can be got in one piece, they should be so disposed as to have every other one with the butt end the same way; for this reason, that the butts will decay before the tops. In large ships the beams are made in two or three pieces, and are therefore allowed to be stronger than those that are in one piece. The beams in two pieces may have the scarf one-third of the length, and those in three pieces should have the middle piece half the length of the whole beam. The customary way of putting them together is to table them; and the length of the tablings should be one-half more than the depth of the beam. It is very common to divide the tablings in the middle of the beam, and that part which is taken out at the upper side to be left at the lower side, and then kersey or flannel is put into the scarf: but in this case the water is liable to lie in the scarf, and must be the means of rotting the beams. If, however, the beams were tabled together in dovetails, and taken through from side to side, putting tar only between them, which hardens the wood; then the water occasioned by the leaking of the decks would have a free passage, and the beam would dry again; and this method would not be found inferior in point of strength to the other. The length of the fore and aft arm of the lodging knee should extend to the side of the hanging knee next to it; but there is no necessity for that arm to be longer than the other. In fastening the knees, care would be taken to let one bolt pass exactly through the middle of the throat, one foot six inches from each end, and the rest divided equally between; observing always to have the holes bored square from the knee. The bolts for the thwartship arms of both hanging and lodging knees may go through the arms of each knee, and drive every one the other way.

In order to draw the beams in the draught, take the moulding of the lower deck beams, and set if off below the line representing the deck at the side, and draw a line in pencil parallel thereto, which will represent the under side of the beams. In like manner represent the under side of the beams for the upper deck, quarter deck, forecastle, and roundhouse. Then take the siding of the lower deck beams, and place one under and one between each port, all fore and aft, drawing them in pencil. Determine the dimensions of the well fore and aft, which is ten feet, and set it off abaft the beam under the eighth port, placing the beam under the ninth port at that distance: those two beams may then be drawn in ink, and will terminate the extent of the well the fore and aft way; and as a beam cannot go across the ship at that place upon account of its being the well and mast room, there must therefore be a beam arm between these two beams.

The main hatchway should then be determined, letting the beam that forms the fore part of the well form the aft part of it, and the beam under the next part may form the fore side of it, which beam may also be now drawn in ink: there should also be another beam arm introduced in the wake of the main hatchway.

The fore hatchway may be next determined; the fore side of which should range well up and down with the after end of the forecastle, and it may be fore and aft about four-sevenths of the main hatchway. At the foreside of the fore hatchway there must be a ladderway down to the orlop, which may be as much fore and aft as the beams will allow. The rest of the beams afore the fore hatchway may remain as first placed, there being nothing in the way to alter the ship. Then determine on the after hatchway, the foreside of which comes to the aft side of the mainmast room.

There should also be a hatchway, the foreside of which may be formed by the aft side of the beam under the twelfth port; which is for the conveniency of the spirit and fish rooms: and there should be a ladderway abaft it to lead down to the cockpit. There may be also another hatchway, the foreside of it to be formed by the aft side of the beam under the eleventh port. The size of the ladder and hatchways must be governed by the beams, as when there is a good shift of beams they should not be altered for ladder and hatchways, unless it is the three principal hatchways, which must always be of a proper size, according to the size of the ship.

The after capstan must be placed between the two hatchways last described, and the beams abaft may stand as they are already shifted, observing only the mizenmast. There should be a small scuttle placed afore the second beam from aft, for the convenience of the bread room: it must be on one side of the middle lines, as there is a carling at the middle under the four or five after beams to receive the pillars for the support thereof.

The bits may be placed, letting the foreside of the after ones come against the aft side of the beam abaft the third port, and the foreside of the foremost ones against the next beam but one forward: then at the foreside of each bit there should be drawn a small scuttle for the conveniency of handing up the powder from the magazine. The breast hook should also be drawn, which may be three feet the moulding away, and sided nine-tenths of the beams of the lower deck.

The gun-deck, beams, knees, &c. being described; in which, as well as all the decks having ports, the same precautions are to be used as in the gun-deck; and ob-

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ferving to keep the beams upon one deck as nearly as poffible over the beams of the other, for the conveniency of pillaring, as they will then fupport each other.

The hatchways are to be placed exactly over thofe on the lower deck, each over each; and therefore, where there is a beam arm in the lower deck there muft alfo be one above it in the upper deck, and the fame in the middle deck in three-deck fhips. It commonly happens in fhips of the line that there cannot be a whole beam between the deck breaft hook and the beam that fupports the ftep of the bowfprit, becaufe the bowfprit paffes through that place: in this cafe, there muft be a beam arm placed, letting the end come equally between the beam and the breaft hook: but in fhips that the bowfprit will allow of a whole beam, then the ports and the reft of the beams muft be confulted in order to fpace it; and when it fo happens that the fore maft comes in the wake of a port, then a beam arm muft be neceffarily introduced.

Having placed the beams according to the difpofition of the other beams below, the ladderways fhould be contrived: there fhould be one next abaft the fore hatchway, which is a fingle ladderway, and one next afore the main hatch, which is a double ladderway; the ladders ftanding the fore and aft way. There fhould alfo be another next abaft the after hatch, and one over the cockpit correfponding with that on the lower deck.

The capftans are next to be confidered; the after one is already placed on the lower deck, the barrel of which muft pafs through the upper deck to receive the whelps and drumhead there, it being a double capftan. In fhips having three decks, the upper part of each capftan is in the middle deck; but in fhips with one deck there is only this one capftan, the upper part of which is placed on the quarter deck. The foremoft capftan fhould be placed in the moft convenient fpot, to admit of its being lowered down to the orlop out of the way of the long boat: it may therefore be placed between the main and fore hatchways; the beam under the fixth port of the lower deck may form the aft fide of its room, and the beams on each fide of it fhould be placed exactly over or under the beams on the other decks, and they fhould be at a diftance from each other fufficient to let the drumheads pafs between them. The centre of the capftan fhould then be placed in the middle between the beams which compofe its room; and the partners fhould be fitted in fuch a manner as to fhift occafionally when wanted, which is by letting them be in two pieces fitted together. The partners on the lower deck, wherein the capftan fteps, muft be fupported by a pillar on the orlop deck, the lower part of which may be fitted in an oak chock; fo that when the pillar is taken away, and the capftan lowered down, that chock ferves as a ftep for the capftan. Thofe two beams on the orlop, by having the pillar and chock upon them, have therefore the whole weight of the capftan preffing downwards: for the fupport of them, there fhould be a carling placed underneath the fore and aft way, with three pillars, one under each beam, and one between; all of them being ftept in the kelfon, by which the orlop deck will be well fupported in the wake of the capftan, and the other decks will feel no ftrain from it.

The fire hearth is next to be difpofed; which is placed differently according to the fize of the fhip. In three-deckers it is found moft convenient to place it on the middle deck; whence there is much more room under the forecaftle than there would have been had it been placed there. In all two-deck fhips it is placed under the forecaftle, becaufe on the deck underneath the bits are in the way. It is alfo under the forecaftle in one-deck fhips, though confined between the bits: in this cafe it fhould be kept as near as poffible to the after bits, that there may be more room between it and the foremoft bits to make a good galley.

The pofitions of the main-topfail-fheet bits are next to be determined; the foremoft of which muft be fo placed as to let its forefide come againft the aft fide of the beam abaft the main hatchway, and to pafs down to the lower deck, and there ftep in the beams: admitting it to be a ftraight piece, it would come at the aft fide of the lower deck beam the fame as it does at the upper deck beam, in confequence of thofe two beams ranging well up and down with each other: it muft therefore have a caft under the upper deck beam, by which the lower part may be brought forward fufficient to ftop in the lower deck beam. The aftermoft muft be placed againft the forefide of the beam abaft the maft, and ftep on the beam below; but there is no neceffity to provide a crooked piece as before, for the beam of the upper deck may be moved a little farther aft, till it admit of the bit ftopping on the lower deck beam, unlefs the beam comes under a port, as in that cafe it muft not by any means be moved. The crofs pieces to the bits fhould be on the forefide, and in height from the upper deck about one-third of the height between it and the quarter deck. With regard to the heads of the bits, the length of the fhip's wafte fhould be confidered; and if there is length enough from the forecaftle to the foremoft bits to admit of the fpare geer being ftowed thereon without reaching farther aft, the quarter deck may then run fo far forward that the head of the foremoft bits fhall tenon in the foremoft beam; this gives the mainmaft another deck, and admits of the quarter deck being all that the longer: but if there is not the room before mentioned, then the quarter deck muft run no further forward than the after bits, which will then tenon in the foremoft beam; and the foremoft bits muft have a crofs piece let on their heads, which is termed a *horfe*, and will be for the purpofe of receiving the ends of the fpare geer.

The length of the quarter deck being now determined, the beams are then to be placed. For this purpofe the feveral contrivances in the quarter deck muft be previoufly confulted. It is neceffary to obferve, that there are neither carlings nor lodges, the carlings of the hatches excepted, in the quarter deck, round-houfe, and forecaftle; as they would weaken inftead of ftrengthening the beams, which fhould be as fmall as the fize of the fhip will permit, in order that the upper works may be as light as poffible. Hence, as there are to be neither carlings nor lodges, the deck will require a greater number of beams, and a good round up, as on the contrary the deck will be apt to bend with its own weight. The moft approved rule is therefore to have double the number of beams in the quarter deck as there are in a fpace of the fame length in the upper deck.

Then proceed to fhift the beams to the beft advantage, Application of the foregoing Rules to the Construction of Ships

tage, consulting the hatchways, ladder-ways, masts, bits, wheel, &c. With respect to the ladder-ways on the quarter decks of all ships, there should be one near the fore part of the great cabin for the officers, and another near the foremost end of the quarter deck, consisting of double ladders for the conveyance of the men up from the other decks in cases of emergency; and likewise one on each side of the fore part of the quarter deck from the gangway: and in every ship of the line all the beams from the foremost ladder-way to the after one should be open with gratings, both for the admission of air, and for the greater expedition of conveying different articles in the time of action.

Two scuttles are to be disposed one on each side of the mainmast, if it happens to come through the quarter deck, for the top tackles to pass through, to hook to the eye bolts drove in the upper deck for that purpose.

The steering wheel should be placed under the forepart of the roundhouse, and the two beams of the quarter deck, which come under it, should be placed conformable to the two uprights, so that they may tenon in them. The quarter deck beams should be kneed at each end with one hanging and one lodging knee; which adds greatly to the strength of the side. The hanging knees which come in the great cabin may be of iron; their vertical arms to be two-thirds of the length of that of wood, and to reach the spirketing. It should be observed, that the beam abaft, which comes under the screen bulkhead, should round aft agreeable to the round of the bulkhead, for the support of the same.

The forecastle beams should be placed according as the works of the deck will admit. The hatchways are therefore to be considered first. There should be one for the funnel of the fire hearth to pass through, and one for the copper to admit of vent for the steam; and also one or two over the galley as the forecastle will admit of. The fore-topsail-sheet bits should be so disposed as to come one pair on the fore and one on the aft side of the mast, to let into the side of the forecastle beams, and step on the upper deck beams below: there should also be a ladder-way at the fore part of the forecastle for the conveniency of the fore part of the ship.

The beams may now be placed agreeable thereto, their number being four more than there are in a space in the upper deck equal in length to the forecastle; and where there happens to be a wide opening between the beams, as in the case of a hatchway, mast room, &c. then half a beam of fir may be introduced to make good the deficiency. The foremost beam should be of a breadth sufficient to take the aft side of the inboard arms of the catheads, as they are secured upon this beam by being bolted thereto. Every beam of the forecastle should be kneed at each end with one hanging and one lodging knee: the vertical arms of the hanging knees should reach the spirketing, and the knees well bolted and carefully clenched.

Proceed to the roundhouse; the same things being observed with respect to the beams as in the quarter deck: for as the roundhouse beams are sided very small, it hence follows that they must be near to each other. Let therefore the number of beams on the roundhouse be four more than in the same length of the quarter deck; every other beam being of fir for lightness, and every oak beam may be kneed at each end with one hanging and one lodging knee; the hanging knees abaft may be of iron, their vertical arms to be in length two thirds of those of wood. The roundhouse should always have a great round up, both for strength and conveniency. There must be on the roundhouse a small pair of knee-bits on each side of the mizenmast, turned round and scarfed over each other, and bolted through the mast carlings. There must also be a companion on the roundhouse placed over the middle of the coach, in order to give light thereto.

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With regard to placing the roundhouse beams, the uprights of the steering wheel and the mizenmast are to be observed; as when the beams which interfere with those parts are properly spaced, the rest may be disposed of at discretion, or at an equal distance from each other, and letting the beam over the screen bulkhead have a proper round aft, agreeable to the quarter deck beam underneath.

The upper parts of the inboard works being now described, proceed next to the lower parts, or to those which come below the lower deck. Draw in the orlop, by taking the heights afore, at midships, and abaft, between that and the gun-deck, from the dimensions, and a curve described through these points will represent the upper part of the deck. Set off the thickness of the plank below, and the under side of the plank will be represented. As this deck does not run quite forward and aft as the other decks, the length of it must be therefore determined; for this purpose let the after beam be placed at a sufficient distance from aft to admit of the bread rooms being of a proper size for the ship, which will be under that beam of the gun-deck that comes at the second part from aft. The after beam being drawn in, proceed to space the other beams, placing them exactly under those of the gun-deck; and that which comes under the foremost beam of the gun-deck may terminate the fore part of the orlop. Draw the limber strake, by setting off its thickness above the cutting down line, and a line drawn parallel thereto will represent the limber strake. That part of the orlop which is over the after magazine, spirit room, and fish room, and also that which is over the fore magazine, is laid with thicker planks than the rest of the deck; which is for the better security of those places, the planks being laid over the beams; but in the midships, from the fore part of the spirit room to the aft part of the fore magazine, the beams are laid level with the surface of the deck, and the planks are rabbeted in from one beam to the other.

In order to represent the orlop as just described, the dimensions of the different apartments above mentioned must be determined: Let the aft side of the after beam be the aft side of the after magazine, and from thence draw the bulkhead down to the limber strake; and the foreside of the third beam may be the foreside of the after magazine, drawing that bulkhead likewise, which will also form the aft side of the fish room; the foreside of the fish room may be drawn from the aft side of the fifth beam, which will also represent the aft side of the spirit room; then the foreside of the spirit room may be drawn from the foreside of the sixth beam. Hence from the foreside of the sixth beam quite aft the deck will

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will be represented by the two lines already drawn, and the upper side of the beams will be represented by the lower line.

Proceed next to the fore part of the orlop, letting the foreside of the after bits be the aft part of the foremost magazine, drawing the bulkhead thereof, which will come to the aft side of the sixth beam; therefore, from the sixth beam to the foremost end of the orlop, the plank and beams will be represented just in the same manner as before mentioned for the after part of the orlop: then the midship part of the deck will be represented by letting the upper line be the upper side of the plank, and likewise the upper side of the beams; and the lower line will represent the lower edge of the plank, only drawing it from beam to beam, and observing not to let it pass through them.

The hatchways, &c. may now be represented on the orlop, letting the main, fore, and after hatchway, be exactly under those of the gun-deck: there must be one over the fish room, and one over the spirit room. There must be two scuttles over the after magazine for the passage to the magazine and light room. There should also be one afore the fourth beam from forward for the passage to the fore magazine, and one abaft the second beam for the passage to the light room.

The bulkheads for the fore and after parts of the well may be drawn from the lower deck beams to the orlop, and from thence to the limber strake in the hold. The shot lockers may also be represented, having one afore and one abaft the well: there should also be one abaft the foremost magazine, the ends of which may be formed by the after bits. The steps of the masts may be drawn in by continuing their centres down to the limber strake; and likewise two crutches abaft the mizen step divided equally between that and the after part of the cutting down: the breast hooks may also be drawn letting them be five in number below the lower deck hook, and all equally divided between that and the fore step. Hence every part of the inboard is described as far as necessary.

Chap. V. *Of the Method of Whole-moulding.*

46 Method of whole-moulding. *Murray's Ship-Building.*

Having now finished the methods of laying down the several plans of a ship, any farther addition on this subject might appear unnecessary. We cannot, however, with propriety, omit to describe the method called *whole-moulding*, used by the ancients, and which still continues in use among those unacquainted with the more proper methods already explained. This method will be illustrated by laying down the several plans of a long-boat; the length of the keel being 29 feet, and breadth moulded nine feet.

47 Applied to a long boat. Plate CCCCXCIII Fig. 37.

Draw the straight line PO (fig. 37.) equal to 29 feet, the extreme length of the boat, and also to represent the upper edge of the keel. Let ⊕ be the station of the midship frame. From the points, P, ⊕, and O, draw the lines PT, ⊕M, and OS, perpendicular to PO. Make ⊕M, ⊕N, equal to the upper and lower heights of breadth respectively at the main frame, PT the height of breadth at the transom, and OS the height at the stem. Describe the curve TMS to represent the sheer or extreme height of the side, which in a ship would be called the *upper height of breadth line*, or upper edge of the wale. Through the point N draw a curve parallel to TMS, to represent the breadth of the upper strake of a boat, or lower edge of the wale if in a ship. The dotted line TNS may also be drawn to represent the lower height of breadth.

Method of Whole-moulding.

Set off the rake of the port from P to p, and draw the line $p\,t$ to represent the aft side of the port; then T t will represent the round-up of the transom. Set off the breadth of the port from p to r, and from T to s, and draw the line r s to represent the foreside of the port, which may either be a curve or a straight line at pleasure. Set up the height of the tuck from p to k. Let k X be the thickness of the transom, and draw the line ZX to represent the foreside of the transom.

There is given the point S, the height of the sheer on the foreside of the stem; now that side of the stem is to be formed either by sweeps or some other contrivance. Set off the breadth of the stem, and form the aft side of it.

Set up the dead-rising from ⊕ to d, and form the rising line r i s. Draw the line KL parallel to PO to represent the lower edge of the keel, and another to represent the thickness of the plank or the rabbet. The rabbet on the post and stem may also be represented; and the stations of the timbers assigned, as ⊕, (1), 1, 2, 3, 4, 5, 6, 7, 8, 9; and ⊕, (A), A, B, C, D, E, F, G, H; and the sheer plan will be completed.

The half-breadth plan is to be formed next; for this purpose the perpendiculars TP, 9, 8, &c. must be produced. Upon M⊕ produced set off the half breadth from the line KL to R (fig. 38.); set off also the half breadth at the transom from K to b, and describe the extreme half-breadth line b RX, making the forepart of the curve agreeable to the proposed round of the transom. Fig. 38.

We may next proceed to form the timbers in the body plan. Let AB (fig. 39.) be the breadth moulded at ⊕. Erect the perpendicular CD in the middle of the line AB; draw the line $m\,n$ distant therefrom the half thickness of the post, and $x\,y$ the half thickness of the stem. Then take off the several portions of the perpendiculars ⊕, 1, 2, &c. intercepted between the upper edge of the keel and the rising line in the sheer plan, and set them up from C upon the line CD; through these points draw lines parallel to AC; take off also the several lower heights of breadth at ⊕, 1, 2, &c. from the sheer plan; and set them up from C upon the middle line in the body plan; and draw lines parallel to AC through these points: Then take off the several half breadths corresponding to each from the floor plan; and set them off on their proper half-breadth lines from the middle line in the body plan. Fig. 39.

Construct the midship frame by Problem V. the form of which will in some measure determine the form of the rest. For if a mould be made on any side of the middle line to fit the curve part of it, and the rising line, or that marked *bend mould* (fig. 40.), and laid in such a manner that the lower part of it, which is straight, may be set upon the several rising lines, and the upper part just touch the point of the half breadth in the breadth line corresponding to that rising upon which the mould is placed, a curve may then be drawn by the mould to the rising line. In this manner we may proceed so far as the rising line is parallel to the lower height of the breadth line. Then a hollow mould must be made, the upper end of which is left straight, as that Fig. 40.

Method of Whole-moulding.

that marked *hollow mould* (fig. 40.). This is applied in such a manner, that some part of the hollow may touch the side of the keel, and the straight part touch the back of the curve before described by the bend mould; and, beginning abaft, the straight part will always come lower on every timber, till we come to the midship timber, when it comes to the side of the keel. Having thus formed the timbers, so far as the whole mouldings will serve, the timbers abaft them are next formed. Their half breadths are determined by the sheer and floor plans, which are the only fixed points through which the curves of these timbers must pass. Some form these after timbers before the whole is moulded, and then make the hollow mould, which will be straighter than the hollow of either of these timbers. It is indifferent which are first formed, or what methods are used; for after the timbers are all formed, though every timber may appear very fair when considered by itself, it is uncertain what the form of the side will be. In order to find which, we must form several ribband and water lines; and if these do not make fair curves, they must be rectified, and the timbers formed from these ribband and water lines. In using the hollow mould, when it is applied to the curve of each timber, if the straight part is produced to the middle line, we shall have as many points of intersection as there are timbers; and if the heights above the base be transferred to the corresponding timbers in the sheer plan, a curve passing through these points is what is called a *rising strait*. This may be formed by fixing a point for the aftermost timber that is whole moulded, and transferring that height to the sheer plan. The curve must pass through this point, and fall in with the rising line somewhere abaft dead flat; and if the several heights of this line be transferred from the sheer to the middle line in the body plan, these points will regulate what is called the *hauling down* of the hollow mould.

The timbers in the after body being all formed, those in the fore body are formed in the same manner, by transferring the several heights of the rising and breadth lines from the sheer to the body plans; the half breadths corresponding to each height must also be transferred from the floor to the body plan. The same hollow mould will serve both for the fore and after body; and the level lines, by which the water lines to prove the after body were formed, may be produced into the fore body, and by them the water lines to prove the fore body may be described.

Another method of proving the body is by ribband lines, which are formed by sections of planes inclined to the sheer plan, and intersecting the body plan diagonally, as before observed, of which there may be as many as may be judged necessary. As this has been already explained, we shall therefore lay down only one, represented in the body plan by the lines marked d i a. These are drawn in such a manner as to be perpendicular to as many timbers as conveniently may be. After they are drawn in the body plan, the several portions of the diagonal intercepted between the middle line and each timber must be transferred to the floor plan. Thus, fix one foot of the compasses in the point where the diagonal intersects the middle line in the body plan; extend the other foot to the point where the diagonal intersects the timber; for example, timber 9: Set off the same extent upon the perpendicular representing the plane of timber 9 from the point where it intersects the line KL on the floor plan: in like manner proceed with all the other timbers both in the fore and after body; and these shall have the points through which the curve must pass. If this should not prove a fair curve, it must be altered, observing to conform to the points as nearly as the nature of the curve will admit: so it may be carried within one point, and without another, according as we find the timbers will allow. For after all the ribband lines are formed, the timbers must, if needful, be altered by the ribband lines: this is only the reverse of forming the ribband lines; for taking the portions of the several perpendiculars intercepted between the line KL and the curve of the ribband line in the floor plan, and setting them off upon the diagonal from the point where it intersects the middle line, we shall have the points in the diagonal through which the curves of the timbers must pass. Thus the distance between the line KL and the ribband at timber 3 on the floor plan, when transferred to the body plan, will extend on the diagonal from the middle line to the point where the curve of timber 3 intersects that diagonal. The like may be said of all the other timbers; and if several ribband lines be formed, they may be so contrived that their diagonals in the body plan shall be at such distances, that a point for every timber being given in each diagonal, will be sufficient to determine the form of all the timbers.

In stationing the timbers upon the keel for a boat, there must be room for two futtocks in the space before or abaft ⊕; for which reason, the distance between these two timbers will be as much more than that between the other as the timber is broad. Here it is between ⊕ and (A); which contains the distances between ⊕ and (1), and the breadth of the timber besides.

The timbers being now formed, and proved by ribband and water lines, proceed then to form the transom, fashion-pieces, &c. by Problem VI.

This method of whole moulding will not answer for the long timbers afore and abaft. They are generally canted in the same manner as those for a ship. In order to render this method more complete, we shall here describe the manner of moulding the timbers after they are laid down in the mould loft, by a rising square, bend, and hollow mould.

It was shown before how to form the timbers by the bend and hollow moulds on the draught. The same method must be used in the loft; but the moulds must be made to their proper scantlings in real feet and inches. Now when they are set, as before directed, for moulding each timber, let the middle line in the body plan be drawn across the bend mould, and draw a line across the hollow mould at the point where it touches the upper edge of the keel; and let them be marked with the proper name of the timber, as in fig. 40. The graduations of the bend mould will therefore be exactly the same as the narrowing of the breadth. Thus, the distance between ⊕ and 7 on the bend mould is equal to the difference between the half breadth of timber 7 and that of ⊕. The height of the head of each timber is likewise marked on the bend mould, and also the floor and breadth firmarks. The floor firmark is in that point where a straight edged batten touches the back

back of the bend mould, the batten being ſo placed as to touch the lower edge of the keel at the ſame time. The ſeveral riſings of the floor and heights of the cutting down line are marked on the riſing ſquare, and the half breadth of the keel is ſet off from the ſide of it.

The moulds being thus prepared, we ſhall apply them to mould timber 7. The timber being firſt properly ſided to its breadth, lay the bend mould upon it, ſo as may beſt anſwer the round according to the grain of the wood; then lay the riſing ſquare to the bottom of the bend mould, ſo that the line drawn acroſs the bend mould at timber 7 may coincide with the line repreſenting the middle of the keel upon the riſing ſquare; and draw a line upon the timber by the ſide of the ſquare, or let the line be ſcored or cut by a tool made for that purpoſe, called a *raſeing knife* (E); this line ſo raſed will be the ſide of the keel. Then the ſquare muſt be moved till the ſide of it comes to 7 on the bend mould, and another line muſt be raiſed in by the ſide of it to repreſent the middle of the keel. The other ſide of the keel muſt likewiſe be raſed after the ſame manner, and the point 7 on the riſing ſquare be marked on each ſide of the keel, and a line raſed acroſs at theſe points to repreſent the upper edge of the keel. From this line the height of the cutting-down line at 7 muſt be ſet up, and then the riſing ſquare may be taken away, and the timber may be raiſed by the bend mould, both inſide and outſide, from the head to the floor firmark, or it may be carried lower if neceſſary. After the firmarks and head of the timbers are marked, the bend mould may likewiſe be taken away, and then the hollow mould applied to the back of the ſweep in ſuch a manner that the point 7 upon it may interſect the upper ſide of the keel, before ſet off by the riſing ſquare; and when in this poſition the timber may be raſed by it, which will complete the outſide of the timbers. The inſide of the timbers may likewiſe be formed by the hollow mould. The ſcantling at the keel is given by the cutting down before ſet off. The mould muſt be ſo placed as to touch the ſweep of the inſide of the timber formed before by the bend mould, and paſs through the cutting down point.

The uſe of the firmarks is to find the true places of the futtocks; for as they are cut off three or four inches ſhort of the keel, they muſt be ſo placed that the futtock and floor firmarks may be compared and coincide. Notwithſtanding which, if the timbers are not very carefully trimmed, the head of the futtock may be either within or without its proper half breadth; to prevent which a half breadth ſtaff is made uſe of.

The half breadth ſtaff may be one inch ſquare, and of any convenient length. Upon one ſide of it are ſet off from one end the ſeveral half-breadths of all the timbers in the after body, and theſe of the fore body upon the oppoſite ſide. On the other two ſides are ſet off the ſeveral heights of the ſheer, the after body on one ſide, and the fore body on its oppoſite. Two ſides of the ſtaff are marked *half breadths*, and the other two ſides *heights of the ſheer*.

The ſtaff being thus prepared, and the floor timbers faſtened on the keel, and levelled acroſs, the futtocks muſt next be faſtened to the floor timbers; but they muſt be ſet firſt to their proper half breadth and height. The half breadth ſtaff, with the aſſiſtance of the ram-line *, ſerves to ſet them to the half breadth; for as the keel of a boat is generally perpendicular to the horizon, therefore the line at which the plummet is ſuſpended, and which is moveable on the ram line, will be perpendicular to the keel. Whence we may by it ſet the timbers perpendicular to the keel, and then ſet them to their proper half breadths by the ſtaff: and when the two firmarks coincide, the futtock will be at its proper height, and may be nailed to the floor timbers, and alſo to the breadth ribband, which may be ſet to the height of the ſheer by a level laid acroſs, taking the height of the ſheer by the ſtaff from the upper ſide of the keel; by which means we ſhall diſcover if the ribband is exactly the height of the ſheer; and if not, the true height may be ſet off by a pair of compaſſes from the level, and marked on the timbers.

* See next chapter.

CHAP. VI. *Of the Practice of Ship-building.*

THE elevation, projection, and half breadth plans, of a propoſed ſhip being laid down on paper, we muſt next proceed to lay down theſe ſeveral plans on the mould loft of the real dimenſions of the ſhip propoſed to be built, and from which moulds for each ſeparate part are to be made. The method of laying down theſe plans, from what has been already ſaid, will, it is preſumed, be no very difficult taſk to accompliſh, as it is no more than enlarging the dimenſions of the original draughts; and with reſpect to the moulds, they are very eaſily formed agreeable to the figure of the ſeveral parts of the ſhip laid down in the mould loft.

Blocks of wood are now to be prepared upon which the keel is to be laid. Theſe blocks are to be placed at nearly equal diſtances, as of five or ſix feet, and in ſuch a manner that their upper ſurfaces may be exactly in the ſame plane, and their middle in the ſame ſtraight line. This laſt is eaſily done by means of a line ſtretched a little more than the propoſed length of the keel; and the upper planes of theſe blocks may be verified by a long and ſtraight rule; and the utmoſt care and precaution muſt be taken to have theſe blocks properly bedded. Each block may be about ſix or eight inches longer than the keel is in thickneſs; their breadth from 12 to 14 inches, and their depth from a foot to a foot and half.

The dimenſions of the keel are to be taken from the mould loft, and the keel is to be prepared accordingly. As, however, it is ſeldom poſſible to procure a piece of wood of ſufficient length for a keel, eſpecially if for a large ſhip, it is, therefore, for the moſt part neceſſary to compoſe it of ſeveral pieces, and theſe pieces are to be ſcarfed together, and ſecurely bolted, ſo as to make one entire piece. It muſt, however, be obſerved, that the pieces which compoſe the keel ought to be of ſuch lengths, that a ſcarf may not be oppoſite to the ſtep of any of the maſts. Rabbets are to be formed on each ſide of the keel to receive the edge of the planks next to

(E) The term *raſeing* is uſed when any line is drawn by ſuch an inſtrument inſtead of a pencil.

Practice of Ship-building.

to it, or garboard ſtrake, and the keel is to be laid on the blocks (F).

The ſtem, and the poſt, and the ſeveral tranſoms belonging to it, are to be prepared from the moulds, and rabbeted in like manner as the keel, to receive the ends of the plank. The tranſoms are to be bolted to the poſt at their middle, each at its reſpective height, taken from the elevation in the mould loft, and the extremities of the tranſoms are to be firmly connected with the faſhion-pieces. Both ſtem and poſt are then to be erected, each at its reſpective extremity of the keel. The tenons at the heel of each being let into mortiſes prepared to receive them, and being ſet to their proper rakes or angles with the keel, are to be ſupported by props or ſhores. Pieces of wood called *dead wood* are to be laid upon and fixed to the upper ſide of the keel towards the fore and aft parts of it; the deepneſs of the dead wood increaſing with its diſtance from the middle, agreeable to the propoſed form of the cutting-down line.

A line is to be ſtretched from the middle of the head of the ſtem to that of the poſt, called the *ram line*, upon which is a moveable line with a plummet affixed to it. The midſhip and other frames are to be erected upon the keel at their proper ſtations. The extremities of each frame are ſet at equal diſtances from the vertical longitudinal ſection of the ſhip, by moving the frame in its own plane until the plumb-line coincides with a mark at the middle between the arms of each frame; and although the keel is inclined to the horizon, yet the frames may alſo be ſet perpendicular to the keel by means of the plumb-line. The ſhores which are ſupporting the frames are now to be ſecurely fixed, that the poſition of the frames may not be altered. The ribbands are now to be nailed to the frames at their proper places, the more effectually to ſecure them; and the intermediate vacancies between the frames filled up with filling timbers. For a perſpective view of a ſhip framed, ſee fig. 2.

Plate cccclxxxiv. Fig. 2.

The frames being now ſtationed, proceed next to fix on the planks, of which the wales are the principal, being much thicker and ſtronger than the reſt. The harpins, which may be conſidered as a continuation of the wales at their fore ends, are fixed acroſs the hawſe pieces, and ſurround the fore part of the ſhip. The planks that incloſe the ſhip's ſides are then brought about the timbers; and the clamps, which are of equal thickneſs with the wales, fixed oppoſite to the wales within the ſhip. Theſe are uſed to ſupport the ends of the beams, and accordingly ſtretch from one end of the ſhip to the other. The thick ſtuff or ſtrong planks of the bottom within board are then placed oppoſite to the ſeveral ſcarfs of the timbers, to reinforce them throughout the ſhip's length. The planks employed to line the ſhip, called the *ceiling* or *foot-waling*, is next fixed in the intervals between the thick ſtuff of the hold. The beams are afterwards laid acroſs the ſhip to ſupport the decks, and are connected to the ſide by lodging and hanging knees: the former of which are exhibited at F, Plate CLXIX. See alſo the article DECK; and the hanging-knees, together with the breadth, thickneſs, and poſition of the keel, floor timbers, futtocks, top-timbers, wales, clamps, thick ſtuff, planks within and without, beams, decks, &c.

The croſs-pillars being next erected, the *carlings* and *ledges*, repreſented in Plate CLXIX. are diſpoſed between the beams to ſtrengthen the deck. The *water-ways* are then laid on the ends of the beams throughout the ſhip's length, and the ſpirketing fixed cloſe above them.—The upper deck is then planked, and the *ſtring* placed under the *gunnel*, or *plankſheer*, in the waiſt.

Then proceed next to plank the quarter-deck and forecaſtle, and to fix the *partners* of the maſts and capſterns with the *coamings* of the hatches. The *breaſt-hooks* are then bolted acroſs the ſtem and bow within-board, the ſtep of the foremaſt placed on the kelſon, and the *riders* fayed to the inſide of the timbers, to reinforce the ſides in different parts of the ſhip's length. The *pointers*, if any, are afterwards fixed acroſs the hold diagonally to ſupport the beams; and the crotches ſtationed in the after hold to unite the half timbers. The *ſteps* of the mainmaſt and capſterns are next placed; the planks of the lower deck and orlop laid; the *navel-hoods* fayed to the hawſe holes; and the *knees of the head*, or cut-water, connected to the ſtem. The figure of the head is then erected, and the *trail-board* and cheeks fixed on the ſide of the knee.

The *taffarel* and *quarter-pieces*, which terminate the ſhip abaft, the former above and the latter on each ſide, are then diſpoſed, and the ſtern and quarter galleries framed and ſupported by their brackets. The *pumps*, with their well, are next fixed in the hold; the *limber boards* laid on each ſide of the kelſon, and the *garboard ſtrake* fixed on the ſhip's bottom next to the keel without.

The hull being thus fabricated, proceed to ſeparate the apartments by bulkheads or partitions, to frame the port-lids, to fix the catheads and cheſs-trees; to form the hatchways and ſcuttles, and fit them with proper covers or gratings. Next fix the ladders at the different hatchways, and build the manger on the lower deck, to carry off the water that runs in at the hawſe-holes when the ſhip rides at anchor in a ſea. The bread-room and magazines are then lined; and the gunnel, rails, and gangways fixed on the upper part of the ſhip. The cleats, kevels, and ranges, by which the ropes are faſtened, are afterwards bolted or nailed to the ſides in different places.

The rudder, being fitted with its irons, is next hung to the ſtern-poſt, and the tiller or bar, by which it is managed, let into a mortiſe at its upper end. The *ſcuppers*, or leaden tubes, that carry the water off from the decks, are then placed in holes cut through the ſhip's ſides; and the *ſtandards* bolted to the beams and ſides above the decks to which they belong. The poop lanthorns are laſt fixed upon their cranes over the ſtern, and the *bilge-ways* or *cradles* placed under the bottom to conduct the ſhip ſteadily into the water whilſt launching.

As

(F) In ſhips of war, which are a long while in building, it has been found that the keel is often apt to rot before they are finiſhed. Upon this account, therefore, ſome builders have begun with the floor timbers, and added the keel afterwards.

Improvements in the Masts and Rudder.

As the various pieces which have been mentioned above are explained at large in their proper places, it is therefore superfluous to enter into a more particular description of them here.

CHAP. VII. *Of Improvements in the Masts and Rudder.*

48 Improvements in masts.

AN account of a method for restoring masts of ships when wounded, or otherwise injured, in an easy, cheap, and expeditious manner, by Captain Edward Pakenham of the royal navy, has been published in the tenth volume of the Transactions of the Society for the Encouragement of Arts, &c. Captain Pakenham introduces his invention with the following observations:

49 Of wounded masts, by Captain Pakenham. Page 209.

"Among the various accidents which ships are liable to at sea, none call more for the attention and exertion of the officer than the speedy refitting of the masts; and having observed, in the course of last war, the very great destruction made among the lower masts of our ship's from the enemy's mode of fighting, as well as the very great expence and delay in refitting a fleet after an action, particularly across the Atlantic—a very simple expedient has suggested itself to me as a resource in part; which appears so very speedy and secure, that the capacity of the meanest sailor will at once conceive it. I therefore think it my duty to state my ideas of the advantages likely to result from it; and I shall feel myself exceedingly happy should they in anywise contribute to remedy the evil.

"My plan, therefore, is, to have the heels of all lower masts so formed as to become the heads: but it is not the intention of the above plan to have the smallest alteration made in the heels of the present lower masts; for as all line-of-battle ships masts are nine inches in diameter larger at the heel than at the head, it will follow, that by letting in the tressel-trees to their proper depth, the mast will form its own cheeks or hounds; and I flatter myself the following advantages will result from the above alteration.

First, I must beg to observe, that all line-of-battle ships bury one third of their lower masts, particularly three-deckers; it therefore follows, that if the wounds are in the upper third, by turning the mast so as to make the heel the head, it will be as good as new; for, in eight actions I was present in last war, I made the following observations:

"That in the said actions fifty-eight lower masts were wounded, and obliged to be shifted, thirty-two of which had their wounds in the upper third, and of course the ships detained until new masts were made. And when it is considered that a lower mast for a 90 or 74 stands government in a sum not less, I am informed, than 2000l. or 2300l. the advantages across the Atlantic resulting from the aforesaid plan will be particularly obvious; not to mention the probability of there being no fit spars in the country, which was the case in the instances of the Isis and Princess Royal; and as I was one of the lieutenants of the Isis at that time, I am more particular in the circumstance of that ship. The Isis had both her lower masts wounded above the cathar pins in her action with the Cæsar, a French 74; and as there were no spars at New York, the Isis was detained five weeks at that place.—Now, if her masts had been fitted on the plan I have proposed, I am confident she would have been ready for sea in 48 hours; and as a further proof, I beg leave to add, that the whole fleet, on the glorious 12th of April, had not the least accident of any consequence except what befel their lower masts, which detained them between eight and ten weeks at Jamaica.

Improvements in the Masts and Rudder.

"The delay of a ship while a new mast is making, and probably the fleet being detained for want of that ship, which frequently occurred in the course of last war, the taking of shipwrights from other work, with a variety of inconveniences not necessary to mention here, must be obvious to every officer that has made the smallest observations on sea-actions.

"You will further observe, that this substitute is formed on the most simple principle, fitted to the meanest capacity, and calculated to benefit all ships, from a first-rate down to the smallest merchantman, in cases of an accident by shot, a spring, a rottenness, particularly as these accidents generally happen in the upper third of the mast and above the cheeks.

"It might probably be objected, that a difficulty and some danger might arise from the wounded part of the mast being below; but this will at once be obviated, when it is remembered, that as the wounded part is below the wedges, it may with ease be both fished, cased, and secured, to any size or degree you please, with the addition of its being wedged on each deck."

Fig. 41. represents a mast of a first-rate in its proper state, the figures representing its thickness at the different divisions. Plate CCXCIII, Fig. 41.

Fig. 42. the same mast inverted, the heel forming the head, and the tressel-trees let into their proper depth, the additional thickness of the mast forming its own cheeks. Fig. 42.

Fig. 43. the proposed mast, the figures representing the thickness of the mast in the proposed alterations; *a*, the heel made square; *b*, the letting in of the tressel-trees; *c*, the third proportion of thickness continued up to where the fourth is in the present mast, or at least some little distance above the lower part of the cheeks, which is always looked upon as the weakest part of the mast; and by its being so proportioned, the mast, when turned, will be nearly as strong in the partners as before. Fig. 43.

As the expence of a mast is much greater than is generally imagined, it is therefore thought proper to subjoin the following statement of the several articles used in making a 74 gun ship's mainmast.

Papers on Naval Architecture. Part 2.

	Value.		
Fishes for a spindle, 21 inches, 2 nails of two masts,	L. 101	3	11
Two side fishes, 22 inches, 2 ditto,	133	10	9
Fore and aft fishes, 22 inches, 2 nails of one mast,	66	13	10
Fish } On the fore part: 21½ inches, 1 nail of half a mast,	29	8	5
Iron } On the fore part: 3 qrs. 19 lbs.	1	5	9
Aries load baulk, 2 loads 22 feet,	12	2	5
Breadthning } Dantzic fir timber: 2 loads 7 feet,	11	1	7
Cheeks } Dantzic fir timber: 4 loads 2 feet,	20	18	4
Iron, 5 cwt. 2 qrs. 24 lb.	8	0	0
Knees, elm timber, 13 feet,	0	15	2
Iron, 2 qrs. 14 lb.	0	17	6
Carried over	L. 385	17	8

Improvement in the Masts and Rudder.

	Value.		
Brought over	L. 385	17	8
Hoops and bolts on the body, 13 cwt. 1 qr. 16 lb.	18	15	0
Treſſel-trees, ſtraight oak timber, ſecond ſort, 2 loads 10 feet,	10	2	4
Iron, 3 qrs. 10 lb.	1	3	6
Croſs trees, ſtraight oak timber, ſecond ſort, 1 load 12 feet,	5	14	0
Iron, 2 qrs. 2 lb.	0	14	6
Cap, elm timber, 1 load 24 feet,	4	6	0
Iron, 2 cwt. 14 lb.	2	19	6
Fullings, bolſters, bollins, and Dantzic fir, 1 load 2 feet,	5	7	8
Workmanſhip,	78	6	0
	L. 513	6	2
Main-topmaſt of a 74 gun ſhip,	50	16	3
Main-top-gallant-maſt,	8	11	0

Principles of Naval Architecture, p. 50.

50
Mr Gordon's plan of building maſts.

In order to leſſen the enormous expence of maſts, a propoſal was made ſome years ago to conſtruct them hollow; and the author having premiſed ſeveral experiments which he had made, proceeds as follows:

"Galileo taught us, that the reſiſtance or ſtrength of a hollow cylinder is to that of a full cylinder, containing the ſame quantity of matter, as the total diameter of the hollow one is to the diameter of the full one; and theſe experiments ſhow us, that the ſtrength or reſiſtance of two or more pieces of wood, faſtened together at each end, and connected by a pillar, pillars, or framing, increaſes, at leaſt to a certain degree, *cæteris paribus*, as the diſtance between them and number of pillars, provided the force is applied in the line or direction of the pillars.

"It is ſurpriſing that this diſcovery of Galileo has not been made ſubſervient to more uſeful purpoſes. It is particularly applicable to the conſtruction of maſts, as not requiring that the hollow cylinder ſhould be made of one ſolid piece of wood (G).

"However, the foregoing experiments teach us, that the ſame advantages may be obtained by other forms beſides that of a cylinder; and that perhaps not only in a ſuperior degree, but likewiſe with greater facility of execution; as by adopting a ſquare figure, but more particularly by conſtructing them of ſeparate pieces of wood, placed at proper diſtances from each other, in the following or any other manner that may be found moſt convenient. Fig. 44, 45, and 46. exhibit each the tranſverſe ſection of a maſt, in which the ſmall circles repreſent the trees or upright pieces of wood, and the lines the beams or framing of wood, which are employed at proper places and at proper diſtances from each other, for connecting them together. Perhaps ſolid frames of wood, placed at proper diſtances from each other, and filling up the whole dotted ſpace, would anſwer better; in which event, the maſt could be ſtrongly hooped with iron at thoſe places, and the upright trees formed ſquare, or of any other convenient form.

Fig. 44.
Fig. 45.
Fig. 46.

"It will be evident to thoſe acquainted with this ſubject, that ſuch maſts would be greatly ſtronger than common ones containing the ſame quantity of materials. It is likewiſe evident that they would be leſs apt to ſpring, as being ſupported on a more extended baſe, and affording many conveniences for being better ſecured; and that they might be conſtructed of ſuch wood as at preſent would be deemed altogether improper for maſts: a circumſtance of importance to Britain at all times, but more particularly now, when there is ſuch difficulty in procuring wood proper for the kind of maſts in common uſe."

51
An improvement of the rudder.

An improvement in the rudder has lately taken place in ſeveral ſhips, particularly in ſome of thoſe in the ſervice of the Eaſt India Company. It will, however, be neceſſary previouſly to deſcribe the uſual form of the rudder, in order to ſhow the advantages it poſſeſſes when conſtructed agreeable to the improved method.

Papers on Naval Architecture, Part 1.
Fig. 47.

N° 1. (fig. 47.) repreſents the rudder according to the common method of conſtruction; in which AB is the axis of rotation. It is hence evident that a ſpace conſiderably greater than the tranſverſe ſection of the rudder at the counter muſt be left in the counter for the rudder to revolve in. Thus, let CAB (N° 2.) be the ſection of the rudder at the counter; then there muſt be a ſpace ſimilar to CDE in the counter, in order that the rudder may be moveable as required. Hence, to prevent the water from waſhing up the rudder caſe, a rudder coat, that is, a piece of tarred canvas, is nailed in ſuch a manner to the rudder and counter as to cover the intermediate ſpace: but the canvas being continually waſhed by the ſea, ſoon becomes brittle, and unable to yield to the various turns of the rudder without breaking; in which caſe the ſhip is of courſe left pervious to the waves, even of three or four feet high; in fact, there are few men bred to the ſea who have not been witneſſes to the bad effects of ſuch a ſpace being left ſo ill guarded againſt the ſtroke of the waves; and many ſhips have, with great probability, been ſuppoſed to founder at ſea from the quantity of water ſhipped between the rudder and counter.

Fig. 48.

It was to remedy this defect that the alteration above alluded to took place; which conſiſts in making the upper part AFG (fig. 48. N° 1.) of the rudder ABD cylindrical, and giving that part at the ſame time a caſt forward, ſo that the axis of rotation may by that means be the line AD, paſſing as uſual from E to D, through the centres of the braces which attach the rudder to the ſtern-poſt, and from E to A through the axis of the cylinder AFG, in order that the tranſverſe ſection KH (N° 2.) at the counter may be a circle revolving upon its centre; in which caſe the ſpace of half an inch is more than ſufficient between the rudder and the counter, and conſequently the neceſſity of a rudder coat entirely done away. But as it was foreſeen, that if the rudder

(G) The ſtrength of theſe cylinders would be ſtill further augmented by having ſolid pieces of wood placed within them at proper diſtances, and ſecurely faſtened to them, in the ſame manner, and on the ſame principles, that nature has furniſhed reeds with joints; and for anſwering, in ſome reſpects, the ſame purpoſe as the pillars in the experiments alluded to.

Load-water Line and Ship's Capacity.

rudder by an accident was unſhipped, this alteration might endanger the tearing away of the counter, the hole is made much larger than the tranſverſe ſection of the cylindric part of the rudder, and the ſpace between filled up with pieces of wood ſo fitted to the counter as to be capable of withſtanding the ſhock of the ſea, but to be eaſily carried away with the rudder, leaving the counter, under ſuch circumſtances, in as ſafe a ſtate as it would be agreeable in the preſent form of making rudders in the navy.

CHAP. VIII. *Upon the Poſition of the Load-water Line, and the Capacity of a Ship.*

See Hydrodynamics. THE weight of the quantity of water diſplaced by the bottom of a ſhip is equal to the weight of the ſhip with its rigging, proviſions, and every thing on board. If, therefore, the exact weight of the ſhip when ready for ſea be calculated, and alſo the number of cubic feet in the ſhip's bottom below the load-water line, and hence the weight of the water ſhe diſplaces; it will be known if the load-water line is properly placed in the draught.

Ship Builder's Repoſitory. The poſition of the ſhip in the draught may be either on an even keel, or to draw moſt water abaft; but an even keel is judged to be the beſt poſition in point of velocity, when the ſhip is conſtructed ſuitable thereto, that is, when her natural poſition is ſuch. For when a ſhip is conſtructed to ſwim by the ſtern, and when brought down to her load-water made to ſwim on an even keel (as is the caſe with moſt ſhips that are thus built), her velocity is by that means greatly retarded, and alſo her ſtrength greatly diminiſhed: for the fore-part being brought down lower than it ſhould be, and the middle of the ſhip maintaining its proper depth in the water, the after part is by that means lifted, and the ſhip is then upon an even keel: but in conſequence of her being out of her natural poſition, the after part is always preſſing downwards with a conſiderable ſtrain, which will continue till the ſhip's ſheer is entirely broken, and in time would fall into its natural poſition again: for which reaſon we ſee ſo many ſhips with broken backs, that is, with their ſheers altered in ſuch a manner that the ſheer rounds up, and the higheſt part is in the midſhips.

Such are the diſadvantages ariſing from not paying a due attention to thoſe points in the conſtruction of a draught; therefore, when the load-water line is found to be ſo ſituated at a proper height on the draught, according to the weight given for ſuch a ſhip, and alſo drawn parallel to the keel, as ſuppoſing that to be the beſt ſailing trim, the next thing is to examine whether the body is conſtructed ſuitable thereto, in order to avoid the above-mentioned ill conſequences.

In the firſt place, therefore, we muſt divide the ſhip equally in two lengthwiſe between the fore and after perpendiculars; and the exact number of cubic feet in the whole bottom beneath the load-water line being known, we muſt find whether the number of cubic feet in each part ſo divided is the ſame; and if they are found to be equal, the body of the ſhip may then be ſaid to be conſtructed in all reſpects ſuitable to her ſwimming on an even keel, let the ſhape of the body be whatever it will; and which will be found to be her natural poſition at the load-water line. But if either of the parts ſhould contain a greater number of cubic feet than the other, that part which contains the greateſt will ſwim the moſt out of the water, and conſequently the other will ſwim deepeſt, ſuppoſing the ſhip in her natural poſition for that conſtruction. In order, therefore, to render the ſhip ſuitably conſtructed to the load-water line in the draught, which is parallel to the keel, the number of cubic feet in the leſs part muſt be ſubtracted from the number contained in the greater part, and that part of the body is to be filled out till it has increaſed half the difference of their quantities, and the other part is to be drawn in as much: hence the two parts will be equal, that is, each will contain the ſame number of cubic feet, and the ſhip's body will be conſtructed in a manner ſuitable to her ſwimming on an even keel.

If it is propoſed that the ſhip laid down on the draught ſhall not ſwim on an even keel, but draw more water abaft than afore, then the fore and after parts of the ſhip's body below the load-water line are to be compared; and if theſe parts are unequal, that part which is leaſt is to be filled out by half the difference, and the other part drawn in as much as before.

It will be neceſſary, in the firſt place, to calculate the weight of a ſhip ready equipped for ſea, from the knowledge of the weight of every ſeparate thing in her and belonging to her, as the exact weight of all the timber, iron, lead, maſts, ſails, rigging, and in ſhort all the materials, men, proviſions, and every thing elſe on board of her, from which we ſhall be able afterwards to judge of the truth of the calculation, and whether the load-water line in the draught be placed agreeable thereto. This is indeed a very laborious taſk, upon account of the ſeveral pieces of timber, &c. being of ſo many different figures, and the ſpecific gravity of ſome of the timber entering the conſtruction not being preciſely determined.

In order to aſcertain the weight of the hull, the timber is the firſt thing which comes under conſideration: the number of cubic feet of timber contained in the whole fabric muſt be found; which we ſhall be able to do by help of the draught and the principal dimenſions and ſcantlings; obſerving to diſtinguiſh the different kinds of timber from each other, as they differ conſiderably in weight; then the number of cubic feet contained in the different ſorts of timber being reduced into pounds, and added, will be the weight of the timber. In like manner proceed to find the weight of the iron, lead, paint, &c. and the true weight of the whole will be found.

In reducing quantity to weight, it may be obſerved that a cubic foot of oak is equal to 66 pounds, and the ſpecific gravity of the other materials is as follows: *See Hydrodynamics.*

Water being	1000	Oak is	891.89
Lead is -	11345	Dry elm	702.70
Iron -	7643	Dry fir	648.64

An

Load-water Line and Ship's Capacity.

Plates CCCCXC. CCCCXCI.

52 Estimate of the weight of the eighty gun ship before laid down.

An Estimate of the Weight of the Eighty Gun Ship in Plates CCCCXC. and CCCCXCI. *as fitted for Sea, with Six Months Provisions.*

Weight of the Hull.

	N° of Ft.	N° of lbs.	Tons.	Lbs.
Oak timber at 66 lb. to the cubic foot	48497	3200802	1428	2082
Fir timber at 48 lb. to the cubic foot	4457	213936	95	1136
Elm timber at 52 lb. to the cubic foot	520	27040	12	160
Carve work and lead work		4651	2	171
Iron work, rudder irons, chain-plates, nails, &c.		88254	39	894
Pitch, tar, oakum, and paint - -		17920	8	
Cook-room fitted with fire hearth - -		16123	7	443
Sum - -		3568726	1593	406

Weight of the Furniture.

	N° of lbs.	Tons.	Lbs.
Complete set of masts and yards, with the spare geer -	161000	71	1960
Anchors with their stocks, and master's stores -	39996	17	1916
Rigging - -	69128	30	1928
Sails, complete set, and spare	32008	14	648
Cables and hawsers -	73532	32	1652
Blocks, pumps, and boats	62056	27	1576
Sum - -	437520	195	720

Weight of the Guns and Ammunition.

Guns with their carriages -	377034	168	714
Powder and shot, powder barrels, &c. - - - -	116320	51	2080
Implements for the powder	6500	2	2020
Ditto for guns, crows, handspikes, &c. - - - -	21573	9	1413
Sum - - -	521427	232	1747

Weight of the Officers Stores, &c.

Carpenter's stores - -	20187	9	27
Boatswain's stores - -	21112	9	952
Gunner's stores - -	8964	4	4
Caulker's stores - -	5200	2	720
Surgeon and chaplain's effects	11096	4	2136
Sum - -	66559	29	1599

Weight of the Provisions.

Provisions for six months for 700 men, with all their equipage	858970	383	1050
Water, casks, and captain's table	933900	416	2060
Sum - -	1792870	800	870

Weight of the Men, &c.

	N° of lbs.	Tons.	Lbs.
Seven hundred men with their effects, including the officers and their effects -	316961	141	1121
Ballast - -	1478400	660	
Sum - -	1795361	801	1121

RECAPITULATION.

The hull - -	3568726	1593	406
The furniture - -	437520	195	720
Guns and ammunition -	521427	232	1747
Officers stores - -	66559	29	1599
Provisions - -	1792870	800	870
Weight of the men and ballast	1795361	801	1121
Sum - -	8182463	3652	1983

Agreeable to the above estimate, we find that the eighty gun ship, with every thing on board and fit for sea, when brought down to the load-water line, weighs 8,182,463 pounds, or nearly 3653 tons. It may now be known if the load-water line in the draught be properly placed, by reducing the immersed part of the body into cubic feet. For if the eighty gun ship, when brought down to the load-water line, weighs 3653 tons, the quantity of water displaced must also be 3653 tons: now a cubic foot of salt water being supposed to weigh 74 pounds, if therefore 8182463 be divided by 74, the quotient is 110573, the number of cubical feet which she must displace agreeable to her weight.

It is now necessary to find the number of cubic feet contained in the ship's bottom below the load-water line by calculation. If the bottom was a regular solid, this might be very easily done; but as it is otherwise, we must be satisfied with the following method by approximation, first given by M. Bouguer.

Take the lengths of every other of the lines that represent the frames in the horizontal plane upon the upper water line; then find the sum of these together, with half the foremost and aftermost frames. Now multiply that sum by the distance between the frames, and the product is the area of the water line contained between the foremost and aftermost frames: then find the area of that part abaft the after frame, which forms a trapezium, and also the post and rudder; find also the area of that part afore the foremost frame, and also of the stem and gripe; then these areas being added to that first found, and the sum doubled, will be the area of the surface of the whole water line. The reason of this rule will be obvious to those acquainted with the first principles of mathematics.

53 Method of calculating the contents of a ship.

The areas of the other water line may be found in the same manner: then the sum of all these areas, except that of the uppermost and lowermost, of which only one half of each must be taken, being multiplied by the distance between the water lines (these lines in the plane of elevation being equidistant from each other), and the product will be the solid content of the space contained between the lower and load-water lines.

Add

Load water Line and Ship's Capacity.

Add the area of the lower water line to the area of the upper side of the keel; multiply half that sum by the distance between them, the product will be the solid content of that part between the lower water line and upper edge of the keel, supposing them parallel to each other. But if the lower water line is not parallel to the keel, the above half sum is to be multiplied by the distance between them at the middle of the ship.

The solid contents of the keel must be next found, by multiplying its length by its depth, and that product by the breadth. Then the sum of these solid contents will be the number of cubic feet contained in the immersed part of the ship's bottom, or that part below the load water line.

Determination of the number of Cubic Feet contained in the Bottom of the Eighty Gun Ship. See Plates CCCCXC. and CCCCXCI.

54 Applied to the eighty-gun ship.

The fore body is divided into five, and the after body into ten, equal parts in the horizontal plane; besides the parts contained between the foremost timber and the stem, and the aftermost timber and the post. The plane of elevation is also divided into five equal parts by water lines drawn parallel to the keel. These water lines are also described upon the horizontal plane.

It is to be observed that there must be five inches added to each line that represents a frame in the horizontal plane for the thickness of the plank, that being nearly a mean between the thickness of the plank next the water and that on the lower part of the bottom.

Upper Water Line abaft Dead Flat.

	Ft.	In.
The breadth at		
frame dead flat is 24 feet 10 inches, one-half of which is	12	5
frame (4)	24	10
frame 3	24	10
frame 7	24	10
frame 11	24	10
frame 15	24	9½
frame 19	24	5
frame 23	23	10
frame 27	22	9
frame 31	20	11
frame 35 is 16 feet 3 inches, the half of which is	8	1½
Sum	236	7
Distance between the frames	10	11
Product	2582	8½
Area of that part abaft frame 35	78	0
——— rudder and post	5	6
Sum	2666	2½
		2
Area of the load water line from dead flat aft	5332	5

Second Water Line abaft Dead Flat.

	Ft.	In.
The breadth at		
frame dead flat is 23 feet 10½ inches, the half of which is	11	11¼
frame (4)	23	10½
frame 3	23	10½
frame 7	23	10½
frame 11	23	10½
frame 15	23	8¼
frame 19	23	3¼
frame 23	22	5
frame 27	20	10
frame 31	17	8
frame 35 is 8 feet 6 inches, the half of which is	4	3
Sum	219	7¼
Distance between the frames	10	11
Product	2397	4
Area of that part abaft frame 35	31	7
rudder and post	5	5
Sum	2434	4
		2
Area of the 2d water line from dead flat aft	4868	8

Third Water Line abaft Dead Flat.

	Ft.	In.
The breadth at		
frame dead flat is 22 feet 1½ inches—half	11	0¾
frame (4)	22	1½
frame 3	22	1½
frame 7	22	1½
frame 11	22	1
frame 15	21	5
frame 19	20	8½
frame 23	19	3½
frame 27	16	5
frame 31	11	2½
frame 35 is 4 feet 3 inches—half	2	1½
	190	8¼
	10	11
	2081	8
Area of that part abaft frame 35	14	5⅛
rudder and post	5	6
	2101	7½
		2
Area of the 3d water line from dead flat aft	4203	3

Fourth Water Line abaft Dead Flat.

	Ft.	In.
The breadth at		
frame dead flat is 20 feet 1 inch—half	10	0½
frame (4)	20	1
frame 3	20	1
frame 7	19	11
frame 11	19	7½
frame 15	19	0
Carry over	108	9

Brought

Load-water Line and Ship's Capacity.

		Ft.	In.
	Brought over	1809	9
Breadth at	frame 19	17	$7\frac{1}{2}$
	frame 23	14	10
	frame 27	10	11
	frame 31	5	11
	frame 35 is 1 foot $11\frac{1}{2}$ inches—half	0	$11\frac{1}{2}$
		159	0
		10	11
		1735	9
	Area of that part abaft frame 35	9	9
	rudder and post	5	0
		1750	6
			2
	Area of the 4th water line from dead flat aft	3501	0

Fifth or Lower Water Line abaft Dead Flat.

The breadth at	frame dead flat is 17 feet 2 inches—half	8	7
	frame (4)	17	2
	frame 3	17	2
	frame 7	17	1
	frame 11	16	4
	frame 15	15	4
	frame 19	13	1
	frame 23	8	9
	frame 27	4	10
	frame 31	2	11
	frame 35 is 1 foot $2\frac{1}{2}$ inches—half	0	$7\frac{1}{4}$
		121	$10\frac{1}{4}$
		10	11
		1330	2
	Area of that part abaft frame 35	4	$8\frac{1}{2}$
	rudder and post	4	$6\frac{1}{2}$
		1339	5
			2

Area of the 5th or lower water line from dead flat aft			2678	10
Half the area of the load water line			2666	$2\frac{1}{2}$
Area of the second water line			4868	8
Area of the third water line			4203	3
Area of the fourth water line			3501	0
Half the area of the lower water line			1339	5
Sum			16578	$6\frac{1}{2}$
Distance between the water lines			4	1
Content in cubic feet between the lower and load water lines			67695	$8\frac{1}{2}$
Area of the lower water line	2678	10		
Area of the upper side of the keel	206	4		
Sum	2885	2		
Half	1442	7		
Distance between the lower water line and the keel	4	1		
Cub. feet contained between lower water line and the keel	5890	$6\frac{1}{2}$	5890	$6\frac{1}{2}$
Content of the keel, lower part of rudder, and false keel			464	3
Cubic feet abaft the midship frame under water when loaded			74050	6

Upper or Load water Line afore Dead Flat.

		Ft.	In.
The breadth at	frame dead flat is 24 feet 10 inches—half	12	5
	frame E	24	10
	frame I	24	$8\frac{1}{2}$
	frame N	24	0
	frame Q	21	$10\frac{1}{2}$
	frame W is 15 feet 1 inch—half	7	$6\frac{1}{2}$
	Sum	115	$4\frac{1}{2}$
	Distance between the frames	10	11
	Product	1259	6
	Area of the part afore frame W	80	3
	stem and knee	4	0
	Sum	1343	9
	Multiply by		2
	Area of the load water line from dead flat forward	2687	6

Second Water Line afore Dead Flat.

The breadth at	frame dead flat is 23 feet $10\frac{1}{2}$ inches—half	11	$11\frac{1}{4}$
	frame E	23	10
	frame I	23	5
	frame N	22	5
	frame Q	19	11
	frame W is 11 feet 11 inches—half	5	$11\frac{1}{2}$
	Sum	107	$5\frac{3}{4}$
	Distance between the frames	10	11
	Product	1173	9
	Area of the part afore frame W, with the stem and knee	43	9
	Sum	1217	6
			2
	Area of the second water line from dead flat forward	2435	0

Third Water Line afore Dead Flat.

The breadth at	frame dead flat is 22 feet $1\frac{1}{2}$ inch—half	11	$0\frac{3}{4}$
	frame E	22	1
	frame I	21	8
	frame N	20	1
	frame Q	16	$1\frac{1}{2}$
	frame W is 7 feet—half	3	6
	Sum	94	$6\frac{1}{4}$
	Distance between the frames	10	11
	Product	1031	10
	Area of the part afore W, with the stem and gripe	25	10
	Sum	1057	8
			2
	Area of the third water line from dead flat forward	2115	4

Load-water Line and Ship's Capacity.

Load-water Line and Ship's Capacity.

Fourth Water Line afore Dead Flat.

		Ft.	In.
The breadth at	frame dead flat is 20 feet 1 inch—half	10	0½
	frame E	20	0½
	frame I	19	3
	frame N	16	5
	frame Q	11	2
	frame W is 2 feet nine inches—half	1	4½
Sum		78	3½
Distance between the frames		10	11
Product		854	8
Area of part before W, with the stem and gripe		8	10¾
Sum		863	6¾
			2
Area of fourth water line from dead flat forward		1727	1½

Fifth Water Line afore Dead Flat.

		Ft.	In.
Breadth at	frame dead flat is 17 feet 2 inches—half	8	7
	frame E	16	9
	frame I	14	10
	frame N	10	9½
	frame Q is 5 feet—half	2	6
Sum		53	5½
Distance between the frames		10	11
Product		583	7
Area of part afore Q		26	2½
stem and knee		5	11½
Sum		615	9
			2
Area of the fifth or lower water line from dead flat forward		1231	6
Area of the upper side of the keel		87	4
Sum		1318	10
Half		659	5
Distance between the lower water line and keel		4	1
Content of the part contained between the lower water line and the keel in cub. feet		2692	7¼
Half of the area of the load water line		1343	9
Area of the second water line		2435	0
third water-line		2115	4
fourth water-line		1727	1½
Half the area of the fifth or lower water line		615	9
Sum		8236	11½
Distance between the water lines		4	1

	Ft.	In.
Cubic feet contained between the lower and load water lines	33634	2¾
Cubic feet contained between lower water line and keel	2692	7½
Content of the keel and false keel	196	6
Content afore midship frame under water when loaded	36523	4
Content abaft midship frame	74050	6
Content under water	110573	10
Weight of a cubic foot of salt water		74lbs.
Weight of the whole ship with every thing on board	8182463.8lbs.	

Tonnage of a Ship

As the weight of the ship, with every thing on board, found by this calculation, is equal to that found by estimate; it hence appears that the water line is properly placed in the draught. It now only remains to find whether the body is constructed suitably thereto, that is, whether the ship will be in her natural position when brought down to that line. For this purpose a perpendicular must be erected 27 feet ¼ inch. abaft dead flat, which will be the middle between the two perpendiculars and the place where the centre of gravity should fall, that the ship may swim on an even keel. The solidity of that part of the bottom contained between the said perpendicular and dead flat is then to be calculated, which will be found to be 25846 feet 7 inches.

Solidity of the bottom afore dead flat	36523 f.	4 in.
——— between the middle and dead flat	25846	7
Solid content of the fore part of the bottom	62369	11
Solidity of the bottom abaft dead flat	74050	6
——— between the middle and dead flat	25846	7
Solid content of the aft. part of the bot.	48203	11
——— fore part of the bottom	62369	11
Difference	14166	
Half	7083	

Hence the after part of the ship's bottom is too lean by 7083 cubic feet, and the fore part as much too full. The after part must therefore be filled out until it has received an addition of 7083 feet, and the fore part must be drawn in till it has lost the same quantity, and the bottom will then be constructed suitable to the ship's swimming on an even keel.

Chap. IX. *Of the Tonnage of a Ship.*

55 Proper method of calculating the tonnage of a ship.

This is a question of equal importance and difficulty. By the tonnage of a ship is meant the weight of every thing that can with safety and expediency be taken on board that ship for the purpose of conveyance; it is also called the *ship's burthen*; and it is totally different from the weight of the whole as she floats in the water. It is perhaps best expressed by calling it the *weight of the cargo*. It is of importance, because it is by this that the merchant or freighter judges of the fitness of

Tonnage of a Ship.

of the ship for his purpose. By this government judge of the ships requisite for transport service, and by this are all revenue charges on the ship computed. It is no less difficult to answer this question by any general rule which shall be very exact, because it depends not only on the cubical dimensions of the ship's bottom, but also on the scantling of her whole frame, and in short on the weight of every thing which properly makes part of a ship ready to receive on board her cargo. The weight of timber is variable; the scantling of the frame is no less so. We must therefore be contented with an average value which is not very remote from the truth; and this average is to be obtained, not by any mathematical discussion, but by observation of the burthen or cargo actually received, in a great variety of cases. But some sort of rule of calculation must be made out. This is and must be done by persons not mathematicians. We may therefore expect to find it incapable of being reduced to any principle, and that every builder will have a different rule. Accordingly the rules given for this purpose are in general very whimsical, measures being used and combined in a way that seems quite unconnected with stereometry or the measurement of solids. The rules for calculation are even affected by the interests of the two parties oppositely concerned in the result. The calculation for the tonnage by which the customs are to be exacted by government are quite different from the rule by which the tonnage of a transport hired by government is computed; and the same ship hired as a transport will be computed near one half bigger than when paying importation duties.

Yet the whole of this might be made a very simple business and very exact. When the ship is launched, let her light water line be marked, and this with the cubical contents of the immersed part be noted down, and be ingrossed in the deed by which the property of the ship is conveyed from hand to hand. The weight of her masts, sails, rigging, and sea-stores, is most easily obtained; and every builder can compute the cubical contents of the body when immersed to the load water line. The difference of these is unquestionably the burthen of the ship.

It is evident from what has been already said in the last chapter, that if the number of cubic feet of water which the ship displaces when light, or, which is the same, the number of cubic feet below the light water line, found by the preceding method of calculation, be subtracted from the number of cubic feet contained in the bottom below the load water line, and the remainder reduced to tons by multiplying by 74, the number of pounds in a cubic foot of sea water, and divided by 2240, the number of pounds in a ton, the quotient will be the tonnage.

But as this method is very troublesome, the following rule for this purpose is that which is used in the king's and merchants service.

56
Common rule.

Let fall a perpendicular from the foreside of the stem at the height of the hawse holes (H), and another perpendicular from the back of the main post at the height of the wing transom. From the length between these two perpendiculars deduct three-fifths of the extreme breadth (I), and also as many times 2½ inches as there are feet in the height of the wing transom above the upper edge of the keel; the remainder is the length of the keel for tonnage. Now multiply this length by the extreme breadth, and the product by half the extreme breadth, and this last product divided by 94 is the tonnage required.

Or, multiply the length of the keel for tonnage by the square of the extreme breadth, and the product divided by 188 will give the tonnage.

Calculation of the Tonnage of an Eighty Gun Ship.

57
Calculation of the tonnage of the eighty gun ship.

I. According to the true method.

	Tons.	lbs.
The weight of the ship at her launching draught of water -	1593	406
The weight of the furniture	195	720
The weight of the ship at her light water mark - -	1788	1126
The weight of the ship at the load water mark - -	3652	1983
Real burthen -	1864	857

II. By the common rule.

			Ft.	Inch.
Length from the foreside of the stem at the height of the hawse holes, to the aft side of the main post, at the height of the wing transom -			185	10
Three-fifths of the extreme breadth is - -	29 f.	9½ in.		
Height of the wing transom is 28 f. 4 in. which multiplied by 2½ inches is	6	8½		
Sum	36	6	36	6
Length of the keel for tonnage			149	4
Extreme breadth - -			49	8
Product - - -			7416	10½
Half the extreme breadth -			24	10
			94)184185	8½
Burthen according to the common rule - -			1959	929
Real burthen - -			1864	857
Difference - -			95	72

58
The common rule gives the tonnage of ships of war greater, and of merchant ships less, than the truth.

Hence an eighty gun ship will not carry the tonnage she is rated at by about 95 tons. As the body of this ship is fuller than in ships of war in general, there is therefore a nearer agreement between the tonnages found by the two different methods. It may be observed that ships of war carry less tonnage than they are rated at by the common rule, and that most merchants ships carry

(H) In the merchant service this perpendicular is let fall from the fore side of the stem at the height of the wing transom, by reason of the hawse-holes being generally so very high in merchant ships, and their stems also having a great rake forward.

(I) The breadth understood in this place is the breadth from outside to outside of the plank.

Tonnage of a Ship.

a great deal more. In confirmation of this, it is thought proper to subjoin the dimensions of several ships, with the tonnage calculated therefrom.

1. *Audacious of seventy-four guns.*

Length on the gun deck	168 f.	0 in.
Length of the keel for tonnage	138	0
Extreme breadth	46	9
Depth of the hold	19	9
Launching draught of water { afore	12	0
Launching draught of water { abaft	17	4
Load draught of water { afore	20	6
Load draught of water { abaft	21	6
The weight of the ship at her launching draught of water	1509 t.	678lbs.
The weight of the furniture	120	1500
Weight of the ship at her light water mark	1629	2178
Weight of the ship at her load water mark	2776	498
Real burthen	1146	560

By the common rule.

Length of the keel for tonnage	138 f.	0 in.
Extreme breadth	46	9
Product	6451	6
Half the extreme breadth	23	4½
	94)150803	
Tonnage according to the common rule	1604	643
Real burthen	1146	560
Difference	458	83

2. *An East Indiaman.*

Length between the perpendiculars forward and aft	132 f.	8 in.
Length of the keel for tonnage	105	0
Extreme breadth	38	0
Depth in hold	16	0
Launching draught of water { afore	7	10
Launching draught of water { abaft	11	10
Load draught of water { afore	19	8
Load draught of water { abaft	20	8
The weight of the ship at her launching draught of water	602 t.	2116lbs.
The weight of the furniture	50	124
Weight of the ship at her light water mark	653	
Weight of the ship at her load water mark	1637	1670
Real burden	984	1670

By the common rule.

Keel for tonnage	105 f.
Extreme breadth	38
Product	3999
Half extreme breadth	19
	94)75810

Tonnage	806	1096
Real tonnage	984	1670
Difference	178	574

3. *A Cutter.*

Length of the keel for tonnage	58 f.	0 in.
Extreme breadth	29	0
Launching draught of water { afore	5	10
Launching draught of water { abaft	9	8
Load draught of water { afore	9	0
Load draught of water { abaft	12	0
The weight of the cutter at her launching	147 t.	640 lbs.
Weight of the furniture	9	199
Weight of the cutter at her light water mark	156	839
Weight of the cutter at her load water mark	266	1970
Real burthen	110	1131

By the common rule.

Keel for tonnage	58 f.	
Extreme breadth	29	
Product	1682	
Half extreme breadth	14½	
	94)24389	
Tonnage by the common rule	259	1024
Real tonnage	110	1131
Difference	148	2133

The impropriety of the common rule is hence manifest, as there can be no dependence on it for ascertaining the tonnage of vessels.

We shall now subjoin the following experimental method of finding the tonnage of a ship.

59 Experimental method of determining the tonnage of vessels.

Construct a model agreeable to the draught of the proposed ship, to a scale of about one fourth of an inch to a foot, and let the light and load water lines be marked on it. Then put the model in water, and load it until the surface of the water is exactly at the light water line; and let it be suspended until the water drains off, and then weighed. Now since the weights of similar bodies are in the triplicate ratio of their homologous dimensions, the weight of the ship when light is, therefore, equal to the product of the cube of the number of times the ship exceeds the model by the weight of the model, which is to be reduced to tons. Hence, if the model is constructed to a quarter of an inch scale, and its weight expressed in ounces; then to the constant logarithm 0,4893556, add the logarithm of the weight of the model in ounces, and the sum will be the logarithm of the weight of the ship in tons.

Again, the model is to be loaded until the surface of the water coincides with the load water line. Now the model being weighed, the weight of the ship is to be found by the preceding rule: then the difference between the weights of the ship when light and loaded is the tonnage required.

It

Tonnage of a Ship.

It will alſo be worth while to add the following exact rule of Mr Parkins, who was many years foreman of the ſhipwrights in Chatham dockyard.

1. *For Men of War.*

Take the length of the gun-deck from the rabbet of the ſtem to the rabbet of the ſtern-poſt. $\frac{23}{24}$ of this is to be aſſumed as the *length for tonnage*, = L.

Take the extreme breadth from outſide to outſide of the plank; add this to the length, and take $\frac{1}{21}$ of the ſum; call this the *depth for tonnage*, = D.

Set up this height from the limber ſtrake, and at that height take a breadth alſo from outſide to outſide of plank in the timber when the extreme breadth is found, and another breadth in the middle between that and the limber ſtrake; add together the extreme breadth and theſe two breadths, and take $\frac{1}{3}$ of the ſum for the breadth for tonnage, = D.

Multiply L, D, and B together, and divide by 49. The quotient is the burthen in tons.

The following proof may be given of the accuracy of this rule. Column 1. is the tonnage or burthen by the king's meaſurement; col. 2. is the tonnage by this rule; and, col. 3. is the weight actually received on board theſe ſhips at Blackſtakes:

Victory	100 guns.	2162	1839	1840
London	90	1845	1575	1677
Arrogant	74	1614	1308	1314
Diadem	64	1369	1141	965
Adamant	50	1044	870	886
Dolphin	44	879	737	758
Ampbion	32	667	554	549
Daphne	20	429	329	374

2. *For Ships of Burthen.*

Take the length of the lower deck from the rabbet of the ſtem to the rabbet of the ſtern-poſt; then $\frac{11}{12}$ of this is the length for tonnage, = L.

Add the length of the lower deck to the extreme breadth from outſide to outſide of plank; and take $\frac{1}{35}$ of the ſum for the depth for tonnage, = D.

Set up that depth from the limber ſtrake, and at this height take a breadth from outſide to outſide. Take another at $\frac{2}{3}$ of this height, and another at $\frac{1}{3}$ of the height. Add the extreme breadth and theſe three breadths, and take the 4th of the ſum for the breadth for tonnage, = B.

Multiply L, D, and B, and divide by $36\frac{2}{3}$. The quotient is the burthen in tons.

This rule reſts on the authority of many ſuch trials, as the following:

	King's Meaſm.	Rule.	Actually rec^{d}. on b^{d}.
Northington Indiaman	676	1053	1064
Granby Indiaman	786	1179	1179
Union coallier	193	266	289
Another coallier	182	254	277

CHAP. X. *Of the Scale of Solidity.*

By this ſcale the quantity of water diſplaced by the bottom of the ſhip, for which it is conſtructed, anſwering to a given draught of water, is eaſily obtained; and alſo the additional weight neceſſary to bring her down to the load water line.

Scale of Solidity.

In order to conſtruct this ſcale for a given ſhip, it is neceſſary to calculate the quantity of water diſplaced by the keel, and by that part of the bottom below each water line in the draught. Since the areas of the ſeveral water lines are already computed for the eighty gun ſhip laid down in Plates CCCCXC. and CCCCXCI. the contents of theſe parts may hence be eaſily found for that ſhip, and are as follow.

Draught of water.			*Water diſplaced in*	
			Cubic feet.	*tons. lbs.*
Keel and falſe keel	2 f.	3 in.	660.9	21 1855
Diſt. bet. keel and 5th w. line	4	1	$8583.1\frac{1}{4}$	283 1233
Sum	6	4	$9243.10\frac{3}{4}$	305 848
Diſt. 5th and 4th w. line	4	1	$18657.8\frac{11}{48}$	616 828
Sum	10	5	$27901.7\frac{47}{48}$	921 1676
Diſt. 4th and 3d w. line	4	1	$23574.6\frac{17}{48}$	778 1795
Sum	14	6	$51476.2\frac{1}{4}$	1700 1231
Diſt. 3d and 2d w. line	4	1	$27812.1\frac{1}{24}$	918 1775
Sum	18	7	$79288.3\frac{21}{24}$	2619 766
Diſt. 2d and 1ſt w. line	4	1	$31285.7\frac{19}{24}$	1033 1218
Sum	22	8	$110573.11\frac{1}{4}$	3652 1984

Conſtruct any convenient ſcale of equal parts to repreſent tons, as ſcale N° 1. and another to repreſent feet, as N° 2.

Draw the line AB (fig. 36.) limited at A, but produced indefinitely towards B. Make AC equal to the depth of the keel, 2 feet 3 inches from ſcale N° 2. and through C draw a line parallel to AB, which will repreſent the upper edge of the keel; upon which ſet off C*c* equal to 21 tons 1855 lbs. taken from ſcale N° 1. Again, make AD equal to the diſtance between the lower edge of the keel and the fifth water line, namely, 6 feet 4 inches, and a line drawn through D parallel to AB will be the repreſentation of the lower water line; and make D*b* equal to 305 tons 848 lbs. the correſponding tonnage. In like manner draw the other water lines, and lay off the correſponding tonnages accordingly: then through the points A, *c*, *b*, *e*, *f*, *g*, *h*, draw the curve A*cbefgh*. Through *h* draw *h*B perpendicular to AB, and it will be the greateſt limit of the quantity of water expreſſed in tons diſplaced by the bottom of the ſhip, or that when ſhe is brought down to the load water line. And ſince the ſhip diſplaces 1788 tons at her light water mark, take therefore that quantity from the ſcale N° 1. which being laid upon AB from A to K, and KL drawn perpendicular to AB, will be the repreſentation of the light water

Plate CCCCXCII. 60

Conſtruction of the ſcale of ſolidity for the ſhip of eighty guns.

Scale of Solidity. water line for tonnage. Hence the scale will be completed.

61
Use of the above scale. Let it now be required to find the number of cubic feet displaced when the draught of water is 17 feet, and the number of additional tons necessary to bring her down to the load water mark.

Take the given draught of water 17 feet from the scale N° 2, which laid from it will reach to I; through which draw the line IMN parallel to AB, and intersecting the curve in AC; then the distance IM applied to the scale N° 1, will measure about 2248 tons, the displacement answerable to that draught of water; and MN applied to the same scale will measure about 1405 tons, the additional weight necessary to bring her down to the load water mark. Also the nearest distance between M and the line KL will measure about 460 tons, the weight already on board.

It will conduce very much to facilitate this operation to divide KB into a scale of tons taken from the scale N° 1, beginning at B, and also *h* L, beginning at *h*. Then when the draught of water is taken from the scale N° 2, and laid from it to I, as in the former example, and IMN drawn parallel to AB, and intersecting the curve in M. Now through M draw a line perpendicular to AB, and it will meet KB in a point representing the number of tons aboard, and also *h* L in a point denoting the additional weight necessary to load her.

Again, if the weight on board be given, the corresponding draught of water is obtained as follows.

Find the given number of tons in the scale KB, through which draw a line perpendicular to AB; then through the point of intersection of this line with the curve draw another line parallel to AB. Now the distance between A and the point where the parallel intersected AH being applied to the scale N° 2, will give the draught of water required.

Any other case to which this scale may be applied will be obvious.

BOOK II. *Containing the Properties of Ships*, &c.

CHAP. I. *Of the Equilibrium of Ships.*

SINCE the pressure of fluids is equal in every direction, the bottom of a ship is therefore acted upon by the fluid in which it is immersed; which pressure, for any given portion of surface, is equal to the product of that portion by the depth and density of the fluid: or it is equal to the weight of a column of the fluid whose base is the given surface, and the altitude equal to the distance between the surface of the fluid and the centre of gravity of the surface pressed. Hence a floating body is in equilibrio between two forces, namely, its gravity and the vertical pressure of the fluid; the horizontal pressure being destroyed.

Plate CCCCLIV. Let ABC (fig. 49.) be any body immersed in a fluid whose line of floatation is GH: hence the pressure of the fluid is exerted on every portion of the surface of the immersed part AFCH. Let EF, CD be any two small portions contained between the lines ED, FC, parallel to each other, and to the line of floatation GH: then the pressure exerted upon EF is expressed by $EF \times IK$, IK being the depth of EF or CD; the density of the fluid being supposed equal to 1. In like manner the pressure upon CD is equal to $CD \times IK$. Now since the pressure is in a direction perpendicular to the surface, draw therefore the line EL perpendicular to EF, and DM perpendicular to DC, and make each equal to the depth IK, below the surface. Now the effort or pressure of the fluid upon EF will be expressed by $EF \times EL$, and that upon CD by $CD \times DM$. Complete the parallelograms ON, QS, and the pressure in the direction EL is resolved into EN, EO, the first in a horizontal, and the second in a vertical direction. In like manner, the pressure in the direction DM is resolved into the pressures DS, DQ. Hence the joint effect of the pressures in the horizontal and vertical directions, namely, $EF \times EN$, and $EF \times EO$, will be equal to $EF \times EL$: For the same reason, $CD \times DP + CD \times DQ = CD \times DM$. But the parts of the pressures in a horizontal direction $EF \times EN$, and $CD \times DP$, are equal. For, because of the similar triangles ENL, ERF, and DPM, DSC, we have $\frac{EL}{EN} = \frac{EF}{FR}$ and $\frac{DM}{DP} = \frac{DC}{CS}$: Hence $DM \times CS = DP \times DC$, and $EL \times FR = EN \times EF$. Now since $EL = DM$, and $FR = CS$, therefore $EL \times FR = DM \times CS = DP \times DC = EN \times EF$. Hence since $EF \times EN = DP \times CD$, the effects of the pressures in a horizontal direction are therefore equal and contrary, and consequently destroy each other. Equilibrium of Ships.

The pressure in a vertical direction is represented by $EO \times EF$, $DQ \times DC$, &c. which, because of the similar triangles EOL, ERF, and DLM, DSC, become $EL \times ER$, $DM \times DS$, &c. or $IK \times ER$, $IK \times DS$, &c. By applying the same reasoning to every other portion of the surface of the immersed part of the body, it is hence evident that the sum of the vertical pressures is equal to the sum of the corresponding displaced columns of the fluid. 62

The weight of a ship equal to that of the quantity of water displaced. Hence a floating body is pressed upwards by a force equal to the weight of the quantity of water displaced; and since there is an equilibrium between this force and the weight of the body, therefore the weight of a floating body is equal to the weight of the displaced fluid (K). Hence also the centre of gravity of the body and the centre of gravity of the displaced fluid are in the same vertical, otherwise the body would not be at rest.

63
And the centre of gravity of both are in the same vertical.

CHAP. II. *Upon the Efforts of the Water to bend a Vessel.*

Théorie complette, &c. par Euler, translated by Watson. WHEN it is said that the pressure of the water upon the immersed part of a vessel counterbalances its weight, it is supposed that the different parts of the vessel are so closely connected together, that the forces which act upon its surface are not capable of producing any change. For we may easily conceive, if the connection of the parts were not sufficiently strong, the vessel would run the risk either of being broken in pieces, or of suffering some alteration in its figure.

The vessel is in a situation similar to that of a rod AB

(K) Upon this principle the weight and tonnage of the 80 gun ship laid down were calculated.

Efforts of the Water to bend a Vessel.

AB (fig. 50.), which being acted upon by the forces $A a$, $C c$, $D d$, $B b$, may be maintained in equilibrio, provided it has a sufficient degree of stiffness: but as soon as it begins to give way, it is evident it must bend in a convex manner, since its middle would obey the forces $C c$ and $D d$, while its extremities would be actually drawn downwards by the forces $A a$ and $B b$.

The vessel is generally found in such a situation; and since similar efforts continually act whilst the vessel is immersed in the water, it happens but too often that the keel experiences the bad effect of a strain. It is therefore very important to inquire into the true cause of this accident.

For this purpose, let us conceive the vessel to be divided into two parts by a transverse section through the vertical axis of the vessel, in which both the centre

Plate CCCCXCV. Fig. 51.

of gravity G (fig. 51.) of the whole vessel and that of the immersed part are situated: so that one of them will represent the head part, and the other that of the stern, each of which will be considered separately. Let g be the centre of gravity of the entire weight of the first, and o that of the immersed part corresponding. In like manner, let γ be the centre of gravity of the whole after part, and ω that of its immediate portion.

Now it is plain, that the head will be acted upon by the two forces $g\,m$ and $o\,n$, of which the first will press it down, and the latter push it up. In the same manner, the stern will be pressed down by the force $\gamma\mu$, and pushed by the force $\omega\nu$. But these four forces will maintain themselves in equilibrium, as well as the total

64 The cause of a ship's hogging,

forces reunited in the points G and O, which are equivalent to them; but whilst neither the forces before nor those behind fall in the same direction, the vessel will evidently sustain efforts tending to bend the keel

65 and sagging.

upwards, if the two points $o\,\omega$ are nearer the middle than the two other forces $g\,m$ and $\gamma\mu$. A contrary effect would happen if the points o and ω were more distant from the middle than the points g and γ.

But the first of these two causes usually takes place almost in all vessels, since they have a greater breadth towards the middle, and become more and more narrow towards the extremities; whilst the weight of the vessel is in proportion much more considerable towards the extremities than at the middle. From whence we see, that the greater this difference becomes, the more also will the vessel be subject to the forces which tend to bend its keel upwards. It is therefore from thence that we must judge how much strength it is necessary to give to this part of the vessel, in order to avoid such a consequence.

If other circumstances would permit either to load the vessel more in the middle, or to give to the part immersed a greater capacity towards the head and stern, such an effect would no longer be apprehended. But the destination of most vessels is entirely opposite to such an arrangement: by which means we are obliged to strengthen the keel as much as may be necessary, in order to avoid such a disaster.

We shall conclude this chapter with the following practical observations on the hogging and sagging of ships by Mr Hutchinson of Liverpool:

Practical Seamanship, p. 13.

"When ships with long floors happen to be laid a-dry upon mud or sand, which makes a solid resistance against the long straight floors amidships, in comparison with the two sharp ends, the entrance and run meet with little support, but are pressed down lower than the flat of the floor, and in proportion hogs the ship amidships; which is too well known from experience to occasion many total losses, or do so much damage by hogging them, as to require a vast deal of trouble and expence to save and repair them, so as to get the hog taken out and brought to their proper sheer again: and to do this the more effectually, the owners have often been induced to go to the expence of lengthening them; and by the common method, in proportion as they add to the burden of these ships, by lengthening their too long straight floors in their main bodies amidships, so much do they add to their general weakness to bear hardships either on the ground or afloat; for the scantling of their old timber and plank is not proportionable to bear the additional burden that is added to them.

"But defects of this kind are best proved from real and incontestable facts in common practice. At the very time I was writing upon this subject, I was called upon for my advice by the commander of one of those strong, long, straight floored ships, who was in much trouble and distraction of mind for the damage his ship had taken by the pilot laying her on a hard, gentle sloping sand, at the outside of our docks at Liverpool, where it is common for ships that will take the ground to lie for a tide, when it proves too late to get into our wet docks. After recommending a proper ship carpenter, I went to the ship, which lay with only a small keel, yet was greatly hogged, and the butts of her upper works strained greatly on the lee side; and the seams of her bottom, at the lower futtock heads, vastly opened on the weather side: all which strained parts were agreed upon not to be caulked, but filled with tallow, putty, or clay, &c. with raw bullocks hides, or canvas nailed with battons on her bottom, which prevented her sinking with the flow of the tide, without hindering the pressure of water from righting and closing the seams again as she floated, so as to enable them to keep her free with pumping. This vessel, like many other instances of ships of this construction that I have known, was saved and repaired at a very great expence in our dry repairing docks. And that their bottoms not only hog upwards, but sag (or curve) downwards, to dangerous and fatal degrees, according to the strain or pressure that prevails upon them, will be proved from the following facts:

"It has been long known from experience, that when ships load deep with very heavy cargoes or materials that are stowed too low, it makes them so very laboursome at sea, when the waves run high, as to roll away their masts; and after that misfortune causes them to labour and roll the more, so as to endanger their working and straining themselves to pieces: to prevent which, it has been long a common practice to leave a great part of their fore and after holds empty, and to stow them as high as possible in the main body at midships, which causes the bottoms of these long straight-floored ships to sag downwards, in proportion as the weight of the cargo stowed there exceeds the pressure of the water upwards, so much as to make them dangerously and fatally leaky.

"I have known many instances of those strong ships of 500 or 600 tons burdens built with long straight floors, on the east coast of England, for the coal and timber trade, come loaded with timber from the Baltic

Efforts of the Water to bend a Vessel.

to Liverpool, where they commonly load deep with rock salt, which is too heavy to fill their holds, so that for the above reasons they stowed it high amidships, and left large empty spaces in their fore and after holds, which caused their long straight floors to sag downwards, so much as to make their hold staunchions amidships, at the main hatchway, settle from the beams three or four inches, and their mainmasts settle so much as to oblige them to set up the main rigging when rolling hard at sea, to prevent the masts being rolled away; and they were rendered so leaky as to be obliged to return to Liverpool to get their leaks stopped at great expence. And in order to save the time and expence in discharging them, endeavours were made to find out and stop their leaks, by laying them ashore dry on a level sand; but without effect: for though their bottoms were thus sagged down by their cargoes when afloat, yet when they came a-dry upon the sand, some of their bottoms hogged upwards so much as to raise their mainmasts and pumps so high as to tear their coats from their decks; so that they have been obliged to discharge their cargoes, and give them a repair in the repairing dock, and in some to double their bottoms, to enable them to carry their cargoes with safety, stowed in this manner. From this cause I have known one of these strong ships to founder.

" Among the many instances of ships that have been distressed by carrying cargoes of lead, one sailed from hence bound to Marseilles, which was soon obliged to put back again in great distress, having had four feet water in the hold, by the commander's account, owing to the ship's bottom sagging down to such a degree as made the hold staunchions settle six inches from the lower deck beams amidships; yet it is common with these long straight floored ships, when these heavy cargoes are discharged that make their bottoms sag down, then to hog upwards: so that when they are put into a dry repairing dock, with empty holds, upon straight blocks, they commonly either split the blocks close fore and aft, or damage their keels there, by the whole weight of the ship lying upon them, when none lies upon the blocks under the flat of their floors amidships, that being hogged upwards; which was the case of this ship's bottom; though sagged downwards six inches by her cargo, it was now found hogged so much that her keel did not touch the blocks amidships, which occasioned so much damage to the after part of the keel, as to oblige them to repair it; which is commonly the case with these ships, and therefore deserving particular notice."

In order to prevent these defects in ships, " they should all be built with their floors or bottoms lengthwise, to form an arch with the projecting part downwards, which will naturally not only contribute greatly to prevent their taking damage by their bottoms hogging and straining upwards, either aground or afloat, as has been mentioned, but will, among other advantages, be a help to their sailing, steering, staying, and waring."

Chap. III. *Of the Stability of Ships.*

When a vessel receives an impulse or pressure in a horizontal direction, so as to be inclined in a small degree, the vessel will then either regain its former position as the pressure is taken off, and is in this case said to be possessed of stability; or it will continue in its inclined state; or, lastly, the inclination will increase until the vessel is overturned. With regard to the first case, it is evident that a sufficient degree of stability is necessary in order to sustain the efforts of the wind; but neither of the other two cases must be permitted to have place in vessels.

Stability of Ships.

Let CED (fig. 52.) be the section of a ship passing through its centre of gravity, and perpendicular to the sheer and floor plans; which let be in equilibrium in a fluid; AB being the water line, G the centre of gravity of the whole body, and g that of the immersed part AEB. Let the body receive now a very small inclination, so that $a\,E\,b$ becomes the immersed part, and γ its centre of gravity. From γ draw γ M perpendicular to $a\,b$, and meeting g G, produced, if necessary, in M. If, then, the point M thus found is higher than G the centre of gravity of the whole body, the body will, in this case, return to its former position, the pressure being taken off. If the point M coincides with G, the vessel will remain in its inclined state; but if M be below G, the inclination of the vessel will continually increase until it is entirely overset. Fig. 52.

The point of intersection M is called the *metacenter*, and is the limit of the altitude of the centre of gravity of the whole vessel. Whence it is evident, from what has already been said, that the stability of the vessel increases with the altitude of the metacenter above the centre of gravity: But when the metacenter coincides with the centre of gravity, the vessel has no tendency whatever to move out of the situation into which it may be put. Thus, if the vessel be inclined either to the right or left side, it will remain in that position until a new force is impressed upon it: in this case, therefore, the vessel would not be able to carry sail, and is hence unfit for the purposes of navigation. If the metacenter is below the common centre of gravity, the vessel will instantly overset.

As the determination of the metacenter is of the utmost importance in the construction of ships, it is therefore thought necessary to illustrate this subject more particularly.

Let AEB (fig. 52.) be a section of a ship perpendicular to the keel, and also to the plane of elevation, and passing through the centre of gravity of the ship, and also through the centre of gravity of the immersed part, which let be g.

Now let the ship be supposed to receive a very small inclination, so that the line of floatation is a, b, and γ the centre of gravity of the immersed part a E b. From γ draw γ M perpendicular to $a\,b$, and intersecting GM in M, the metacenter, as before. Hence the pressure of the water will be in the direction γ M.

In order to determine the point M, the metacenter, the position of γ with respect to the lines AB and g G, must be previously ascertained. For this purpose, let the ship be supposed to be divided into a great number of sections by planes perpendicular to the keel, and parallel to each other, and to that formerly drawn, these planes being supposed equidistant. Let AEB (fig. 53.) be one of these sections, g the centre of gravity of the immersed part before inclination, and γ the centre of gravity of the immersed part when the ship is in its inclined state; the distance $g\,\gamma$ between the two centres of Fig. 53.

Stability of Ships.

of gravity in each ſection is to be found. Let AB be the line of floatation of the ſhip when in an upright ſtate, and $a\,b$ the water line when inclined. Then, becauſe the weight of the ſhip remains the ſame, the quantity of water diſplaced will alſo be the ſame in both caſes, and therefore $AEB = a\,E\,b$, each ſuſtaining the ſame part of the whole weight of the ſhip. From each of theſe take the part AEb, which is common to both, and the remainders $AO\,a$, $BO\,b$ will be equal; and which, becauſe the inclination is ſuppoſed very ſmall, may be conſidered as rectilineal triangles, and the point O the middle of AB.

Now, let H, I, K, be the centres of gravity of the ſpaces $AO\,a$, $AE\,b$, and $BO\,b$, reſpectively. From theſe points draw the lines $H\,h$, $I\,i$, and $K\,k$, perpendicular to AB, and let IL be drawn perpendicular to EO. Now to aſcertain the diſtance γq of the centre of gravity γ of the part $a\,E\,b$ from the line AB, the momentum of $a\,E\,b$ with reſpect to this line muſt be put equal to the difference of the momentums of the parts $AE\,b$, $AO\,a$, which are upon different ſides of AB *. Hence $a\,E\,b \times \gamma q$, or $AEB \times \gamma q = AE\,b \times I\,i - AO\,a \times H\,h$. But ſince g is the common centre of gravity of the two parts $AE\,b$, $BO\,b$, we have therefore $AEB \times g\,O = AE\,b \times I\,i + BO\,b \times K\,k$. Hence by expunging the term $AE\,b \times I\,i$ from each of theſe equations, and comparing them, we obtain $AEB \times \gamma q = AEB \times g\,O - BO\,b \times K\,k - AO\,a \times H\,h$.

* Bezout's Mechanique, art. 203.

Now, ſince the triangles $AO\,a$, $BO\,b$, are ſuppoſed infinitely ſmall, their momentums or products, by the infinitely little lines $H\,h$, $K\,k$, will alſo be infinitely ſmall with reſpect to $AEB \times g\,O$; which therefore being rejected, the former equation becomes $AEB \times \gamma q = AEB \times g\,O$, and hence $\gamma q = g\,O$. Whence the centres of gravity γ, g, being at equal diſtances below AB, the infinitely little line γg is therefore perpendicular to EO. For the ſame reaſon $g\gamma$, fig. 52. may be conſidered as an arch of a circle whoſe centre is M.

To determine the value of $g\gamma$, the momentum of $a\,E\,b$ with reſpect to EO muſt be taken, for the ſame reaſon as before, and put equal to the momentums of the two parts $AO\,a$, $AE\,b$; and we ſhall then have $a\,E\,b \times g\gamma$, or $AEB \times g\gamma = AEB \times IL + AO\,a \times O\,h$. But ſince g is the common centre of gravity of the two ſpaces $AE\,b$, $BO\,b$, we ſhall have $AE\,b \times IL - BO\,b \times O\,k = 0$, or $AE\,b \times IL = BO\,b \times O\,k$. Hence $AEB \times g\gamma = BO\,b \times O\,k + AO\,a \times O\,h = 2\,BO\,b \times O\,k$; becauſe the two triangles $AO\,a$, $BO\,b$ are equal, and that the diſtances $O\,k$, $O\,h$, are alſo evidently equal.

Let x be the thickneſs of the ſection repreſented by ABC. Then the momentum of this ſection will be $2\,BO\,b \times x \times O\,k$, which equation will alſo ſerve for each particular ſection.

Now let $\int$ repreſent the ſum of the momentums of all the ſections. Hence $\int AEB \times x \times g\gamma = \int 2 \cdot BO\,b \times x \times O\,k$. Now the firſt member being the ſum of the momentums of each ſection, in proportion to a plane paſſing through the keel, ought therefore to be equal to the ſum of all the ſections, or to the volume of the immerſed part of the bottom multiplied by the diſtance $g\gamma$. Hence V repreſenting the volume, we ſhall have $V \times g\gamma = \int 2\,BO\,b \times x\,O\,k$.

In order to determine the value of the ſecond member of this equation, it may be remarked, that when the ſhip is inclined, the original plane of floatation CBPQ (fig. 54.) becomes $C\,b\,p\,Q$. Now the triangles $NI\,n$, $BO\,b$, being the ſame as thoſe in figures 52. and 53.; and as each of theſe triangles has one angle equal, they may, upon account of their infinite ſmallneſs, be conſidered as ſimilar; and hence $BO\,b : NI\,n :: \overline{OB}|^2 : \overline{IN}|^2$; whence $BO\,b = \frac{\overline{OB}|^2}{\overline{IN}|^2} \times NI\,n$. Moreover, we have (fig. 53.) $O\,k = \frac{2}{3}\,OB$, for the points K and k may be conſidered as equidiſtant from the point O: whence $BO\,b \times O\,k = \frac{\frac{2}{3}\overline{OB}|^3}{\overline{IN}|^2} \times NI\,n$.

Stability of Ships. Fig. 54.

Hence $V \times g\gamma = \int \frac{\frac{4}{3}\overline{OB}|^3}{\overline{IN}|^2} \times x \times NI\,n$. From this equation the value of $g\gamma$ is obtained.

To find the altitude $g\,M$ (fig. 55.) of the metacenter above the centre of gravity of the immerſed part of the bottom, let the arc NS be deſcribed from the centre I with the radius IN; then $NI\,n = \frac{IN \times NS}{2}$. Now ſince the two ſtraight lines γM, $g\,M$ are perpendicular to $a\,n$ and AN reſpectively, the angles M and $NI\,n$ are therefore equal: and the infinitely little portion $g\gamma$, which is perpendicular to $g\,M$, may be conſidered as an arch deſcribed from the centre M. Hence the two ſectors NIS, $g\,M\,\gamma$ are ſimilar; and therefore $g\,M : g\gamma :: IN : NS$. Hence $NS = \frac{IN \times g\gamma}{g\,M}$; and conſequently $NI\,n = \frac{\overline{IN}|^2 \times g\gamma}{2\,g\,M}$. Now this being ſubſtituted in the former equation, and reduced, we have $V \times g\gamma = \int \frac{\frac{2}{3}\overline{OB}|^3 \times x \times g\gamma}{g\,M}$. But ſince $g\,M$ and $g\gamma$ are the ſame, whatever ſection may be under conſideration, the equation may therefore be expreſſed thus, $V \times g\gamma = \frac{\frac{2}{3} g\gamma}{g\,M} \cdot \int \overline{OB}|^3 \times x$. Hence $g\,M = \frac{\frac{2}{3}\int \overline{OB}|^3 \times x}{V}$. Let $y = OB$, and the equation becomes $g\,M = \frac{\frac{2}{3}\int y^3 x}{V}$.

Fig. 55.

Whence to have the altitude of the metacenter above the centre of gravity of the immerſed part of the bottom, the length of the ſection at the water-line muſt be divided by lines perpendicular to the middle line of this ſection into a great number of equal parts, ſo that the portion of the curve contained between any two adjacent perpendiculars may be conſidered as a ſtraight line. Then the ſum of the cubes of the half perpendiculars or ordinates is to be multiplied by the diſtance between the perpendiculars, and two-thirds of the product is to be divided by the volume of the immerſed part of the bottom of the ſhip.

It is hence evident, that while the ſector at the water line is the ſame, and the volume of the immerſed part of the bottom remains alſo the ſame, the altitude of the metacenter will remain the ſame, whatever may be the figure of the bottom.

Chap. IV. *Of the Centre of Gravity of the immerſed Part of the Bottom of a Ship.*

The centre of gravity * of a ſhip, ſuppoſed homogeneous, and in an upright poſition in the water, is in a vertical

* See Mechanics.

Centre of Gravity.

vertical ſection paſſing through the keel, and dividing the ſhip into two equal and ſimilar parts, at a certain diſtance from the ſtern, and altitude above the heel.

In order to determine the centre of gravity of the immerſed part of a ſhip's bottom, we muſt begin with determining the centre of gravity of a ſection of the ſhip parallel to the keel, as ANDFPB (fig. 56.), bounded by the parallel lines AB, DF, and by the equal and ſimilar curves AND, BPF.

Fig. 56.

66 Diſtance of the centre of gravity from the ſtem or ſtern.

If the equation of this curve were known, its centre of gravity would be eaſily found: but as this is not the caſe, let therefore the line CE be drawn through the middle C, E, of the lines AB, DF, and let this line CE be divided into ſo great a number of equal parts by the perpendiculars TH, KM, &c. that the arches of the curves contained between the extremities of any two adjacent perpendiculars may be conſidered as ſtraight lines. The momentums of the trapeziums DTHF, TKMH, &c. relative to the point E, are then to be found, and the ſum of theſe momentums is to be divided by the ſum of the trapeziums, that is, by the ſurface ANDFPB.

The diſtance of the centre of gravity of the trapezium THFD from the point E is $= \frac{\frac{1}{3}\text{IE} \times (\text{DF}+2\text{TH})}{\text{DF}+\text{TH}}$ *.

For the ſame reaſon, and becauſe of the equality of the lines IE, IL, the diſtance of the centre of gravity of the trapezium TKMH from the ſame point E will be $\frac{\frac{1}{3}\text{IE}\times(\text{TH}+2\text{KM})}{\text{TH}+\text{KM}}+\text{IE}$, or $=\frac{\frac{1}{3}\text{IE}\times(4\text{TH}+5\text{KM})}{\text{TH}+\text{KM}}$.

In like manner, the diſtance of the centre of gravity of the trapezium NKMP from the point E will be $\frac{\frac{1}{3}\text{IE}\times(\text{KM}+2\text{NP})}{\text{KM}+\text{NP}}+2\,\text{IE}$, or $\frac{\frac{1}{3}\text{IE}\times(7\,\text{KM}+8\text{NP})}{\text{KM}+\text{NP}}$, &c.

Now, if each diſtance be multiplied by the ſurface of the correſponding trapezium, that is, by the product of half the ſum of the two oppoſite ſides of the trapezium into the common altitude IE, we ſhall have the momentums of theſe trapeziums, namely, $\frac{1}{6}\,\overline{\text{IE}}|^2\times(\text{DF}+2\text{TH})$, $\frac{1}{6}\overline{\text{IE}}|^2\times(4\,\text{TH}+5\,\text{KM})$ $\frac{1}{6}\,\overline{\text{IE}}|^2\times(7\,\text{KM}+8\,\text{NP})$, &c. Hence the ſum of theſe momentums will be $\frac{1}{6}$ $\overline{\text{IE}}|^2\times(\text{DF}+6\,\text{TH}+12\,\text{KM}+18\,\text{NP}+24\,\text{QS}+14\,\text{AB})$. Whence it may be remarked, that if the line CE be divided into a great number of equal parts, the factor or coefficient of the laſt term, which is here 14, will be $= 2+3\,(n-2)$ or $3\,n-4$, n being the number of perpendiculars. Thus the general expreſſion of the ſum of the momentums is reduced to $\overline{\text{IE}}|^2\times(\frac{1}{6}\,\text{DF}+\text{TH}+2\,\text{KM}+3\,\text{NP}+4\,\text{QS}+$, &c. — $+\frac{3\,n-4}{6}\times\text{AB}$.

The area of the figure ANDFPB is equal to IE $\times(\frac{1}{2}\,\text{DF}+\text{TH}+\text{KM}+\text{NP}+$, &c..... $+\frac{1}{2}\,\text{AB})$; hence the diſtance EG of the centre of gravity G from one of the extreme ordinates DF is equal to

67 Rule for the diſtance of the centre of gravity from one of the extreme ordinates.

$$\frac{\text{IE}\times(\frac{1}{6}\text{DF}+\text{TH}+2\,\text{KM}+3\,\text{NP}+,\&\text{c.}\ \frac{3\,n-4}{6}\times\text{AB})}{\frac{1}{2}\,\text{DF}+\text{TH}+\text{KM}+\text{NP}+,\ \&\text{c.}+\frac{1}{2}\,\text{AB}}$$

Whence the following rule to find the diſtance of the centre of gravity G from one of the extreme ordinates DF. To the ſixth of the firſt ordinate add the ſixth of the laſt ordinate multiplied by three times the number of ordinates minus four; then the ſecond ordinate, twice the third, three times the fourth, &c. the ſum will be a firſt term. Then to half the ſum of the extreme ordinates add all the intermediate ones, and the ſum will be a ſecond term. Now the firſt term divided by the ſecond, and the quotient multiplied by the interval between two adjacent perpendiculars, will be the diſtance ſought.

Thus, let there be ſeven perpendiculars, whoſe values are 18, 23, 28, 30, 30, 21, 0, feet reſpectively, and the common interval between the perpendiculars 20 feet. Now the ſixth of the firſt term 18 is 3; and as the laſt term is 0, therefore to 3 add 23, twice 28 or 56, thrice 30 or 90, four times 30 or 120, five times 21 or 105; and the ſum is 397. Then to the half of 18+0, or 9, add the intermediate ordinates, and the ſum will be 141. Now $\frac{397\times20}{141}$, or $\frac{7940}{141}$, $=59$ feet four inches nearly, the diſtance of the centre of gravity from the firſt ordinate.

Now, when the centre of gravity of any ſection is determined, it is eaſy from thence to find the centre of gravity of the ſolid, and conſequently that of the bottom of a ſhip.

68 Height of the centre of gravity above the keel.

The next ſtep is to find the height of the centre of gravity of the bottom above the keel. For this purpoſe the bottom muſt be imagined to be divided into ſections by planes parallel to the keel or water-line, (figs. 57, 58.). Then the ſolidity of each portion contained between two parallel planes will be equal to half the ſum of the two oppoſed ſurfaces multiplied by the diſtance between them; and its centre of gravity will be at the ſame altitude as that of the trapezium *a b c d*, (fig. 58.), which is in the vertical ſection paſſing through the keel. It is hence obvious, that the ſame rule as before is to be applied to find the altitude of the centre of gravity, with this difference only, that the word perpendicular or ordinate is to be changed into ſection. Hence the rule is, to the ſixth part of the loweſt ſection add the product of the ſixth part of the uppermoſt ſection by three times the number of ſections minus four; the ſecond ſection in aſcending twice the third, three times the fourth, &c. the ſum will be a firſt term. To half the ſum of upper and lower ſections add the intermediate ones, the ſum will be a ſecond term. Divide the firſt term by the ſecond, and the quotient multiplied by the diſtance between the ſections will give the altitude of the centre of gravity above the keel.

Fig. 57, 58.

With regard to the centre of gravity of a ſhip, whether it is conſidered as loaded or light, the operation becomes more difficult. The momentum of every different part of the ſhip and cargo muſt be found ſeparately with reſpect to a horizontal and alſo a vertical plane. Now the ſums of theſe two momentums being divided by the weight of the ſhip, will give the altitude of the centre of gravity, and its diſtance from the vertical plane; and as this centre is in a vertical plane paſſing through the axis of the keel, its place is therefore determined. In the calculation of the momentums, it muſt be obſerved to multiply the weight, and not the magnitude of each piece, by the diſtance of its centre of gravity.

A more eaſy method of finding the centre of gravity of

* Bezout's *Mechanique*, art. 279.

Centre of Gravity.

69 A mechanical method for ascertaining the centre of gravity of a ship.

of a ship is by a mechanical operation, as follows: Construct a block of as light wood as possible, exactly similar to the parts of the proposed draught or ship, by a scale of about one-fourth of an inch to a foot. The block is then to be suspended by a silk-thread or very fine line, placed in different situations until it is found to be in a state of equilibrium, and the centre of gravity will be pointed out. The block may be proved by fastening the line which suspends it to any point in the line joining the middles of the stem and post, and weights are to be suspended from the extremities of this middle line at the stem and post. If, then, the block be properly constructed, a plane passing through the line of suspension, and the other two lines, will also pass through the keel, stem, and post. Now, the block being suspended in this manner from any point in the middle line, a line is to be drawn on the block parallel to the line of suspension, so that the plane passing through these two lines may be perpendicular to the vertical plane of the ship in the direction of the keel. The line by which the block is suspended is then to be removed to some other convenient point in the middle line; and another line is to be drawn on the block parallel to the line suspending it, as before. Then the point of intersection of this line with the former will give the position of the centre of gravity on the block, which may now be laid down in the draught.

Chap. V. *Application of the preceding Rules to the Determination of the Centre of Gravity and the Height of the Metacenter above the Centre of Gravity of a Ship of 74 Guns.*

In fig. 59. are laid down the several sections in a horizontal direction, by planes parallel to the keel, and at equal distances from each other, each distance being 10 feet 0 inches 4 parts. Fig. 59.

I. *Determination of the Centre of Gravity of the upper Horizontal Section.*

To find the distance of the centre of gravity of the plane 8 *g o* G from the first ordinate 8 *g*.

Ordinates.			Double Ord.			1st Factors	1st Products.			2d Factors.	2d Products,		
Feet.	In.	P.	Feet.	In.	P.		Feet.	In.	P.		Feet.	In.	P.
14	9	0	29	6	0	$0\frac{1}{6}$	4	11	0	$0\frac{1}{2}$	14	9	0
17	1	6	34	3	0	1	34	3	0	1	34	3	0
18	9	0	37	6	0	2	75	0	0	1	37	6	0
19	10	0	39	8	0	3	119	0	0	1	39	8	0
20	7	6	41	3	0	4	165	0	0	1	41	3	0
21	1	9	42	3	6	5	211	5	6	1	42	3	6
21	6	3	43	0	6	6	258	3	0	1	43	0	6
21	7	9	43	3	6	7	303	0	6	1	43	3	6
21	7	9	43	3	6	8	346	4	0	1	43	3	6
21	7	6	43	3	0	9	389	3	0	1	43	3	0
21	4	0	42	8	0	10	426	8	0	1	42	8	0
20	10	6	41	9	0	11	459	3	0	1	41	9	0
19	9	0	39	6	0	12	474	0	0	1	39	6	0
17	4	6	34	9	0	13	451	9	0	1	34	9	0
13	1	3	26	2	6	$\left((3\times15)-4\right)\times\frac{1}{6}$	179	1	1	$0\frac{1}{2}$	13	1	3
291	1	3	582	2	6		3897	3	1		554	4	3

$$\text{Now } \frac{3897\ \ 3\ \ 1}{554\ \ 4\ \ 3}\times 10\ \ 0\ \ 4=\frac{3897\cdot25}{554\cdot25}\times10.03=70.5.$$

	Feet.
Hence the distance of the centre of gravity of double the plane 8 *g o* G from the first ordinate, 8 *g*, is	70.5
Distance of this ordinate from the aft side of stern-post,	13.5
Distance of the centre of gravity from the aft side of post,	84.0
Distance of the centre of gravity of double the trapezium AR *g* 8 from its ordinate AR,	8.42
Distance of this ordinate from the aft side of the stern-post,	0.58
Distance of the centre of gravity of this plane from the aft-side of the stern-post	9.0
Distance of the centre of gravity of double the trapezium G *o* γ γ from its ordinate G *o*,	5.44
Distance of this ordinate from the aft-side of the post,	153.78
Distance of the centre of gravity of this trapezium from the aft side of the post,	159.22
Distance of the centre of gravity of the section of the stern-post from the aft part of the post,	0.29
Distance of the centre of gravity of the section of the stern from the aft side of the post,	169.76

The

Centre of Gravity.

The areas of these several planes, calculated by the common method, will be as follow:

5558.90 for that of the plane, and its momentum 5558.9×84 =	466947.6000
199.13 for that of double the trapezium ARg8, and its momentum 199.13×9 =	1792.1700
214.59 for that of double the trapezium G$o\gamma\gamma$, and its momentum 214.59×159.22 =	34167.0236
0.77 for that of the section of the stern-post, and its momentum 0.77×0.29 =	0.2233
0.77 for that of the section of the stem, and its momentum 0.77×169.76 =	130.7152
5974.16 Sum - , - - -	503037.7321

Now $\frac{503037.7321}{5974.16} = 84.2$, the distance of the centre of gravity of the whole section from the aft side of the stern-post.

II. *Determination of the Centre of Gravity of the second Horizontal Section.*

To find the distance of the centre of gravity of double the plane $8fn$G from its first ordinate $8f$.

Ordinates. Feet. In. Pts.	Double Ord. Feet In. Pts.	1. Factors.	1. Products. Feet In. Pts.	2. Fact.	2. Products. Feet In. Pts.
11 2 3	22 4 6	$0\frac{1}{3}$	3 8 9	$0\frac{1}{2}$	11 2 3
15 3 0	30 6 0	1	30 6 0	1	30 6 0
17 5 0	34 10 0	2	69 8 0	1	34 10 0
18 10 3	37 8 6	3	113 1 6	1	37 8 6
19 10 6	39 9 0	4	159 0 0	1	39 9 0
20 7 0	41 2 0	5	205 10 0	1	41 2 0
21 0 3	42 0 6	6	252 3 0	1	42 0 6
21 2 0	42 4 0	7	296 4 0	1	42 4 0
21 0 6	42 1 0	8	336 8 0	1	42 1 0
20 10 9	41 9 6	9	376 1 6	1	41 9 6
20 6 6	41 1 0	10	410 10 0	1	41 1 0
19 10 0	39 8 0	11	436 4 0	1	39 8 0
18 6 0	37 0 0	12	444 0 0	1	37 0 0
15 9 6	31 7 0	13	410 7 0	1	31 7 0
11 2 9	22 5 6	$\left((3 \times 15)-4\right) \times \frac{1}{3}$	153 5 6	$0\frac{1}{2}$	11 2 9
273 2 3	546 4 6		3698 5 3		523 11 6

Hence the distance of the centre of gravity of double the plane $8fn$G from its first ordinate $8n$ is

$\frac{3698 \quad 5 \quad 3}{523 \quad 11 \quad 6} \times 10.0.4 = \frac{3698.43}{523.95} \times 10.03 =$ - - -	70.79
Distance of this ordinate from the aft side of the stern-post - -	13.5
Distance of the centre of gravity of the above plane from the aft side of post - -	84.29
Distance of the centre of gravity of double the trapezium ARf8 from its ordinate AR -	8.38
Distance of this ordinate from aft side of stern-post - - -	0.57
Distance of the centre of gravity of the trapezium from the aft side of the post - -	8.95
Distance of the centre of gravity of the trapezium before the ordinate Gn from that ordinate	5.74
Distance of that ordinate from the aft side of the post - - -	153.78
Distance of the centre of gravity of the trapezium from the aft side of the post - -	159.52
Distance of the centre of gravity of the section of the stern-post from the aft side of the post -	0.29
Distance of the centre of gravity of the section of the stem from the aft side of the post -	169.76

The

Centre of Gravity.

The areas of these several planes being calculated, will be as follow:

5255.22 for that of the plane $8fnG$, and its momentum $5255.22 \times 84.29 =$ -	442962.4938
153.11 for that of double the trapezium $ARf8$, and its momentum $153.11 \times 8.95 =$	1370.3345
182.40 the area of the trapezium before, and its momentum $182.40 \times 159.52 =$ -	29096.4480
0.77 the area of the section of the sternpost, and its momentum $0.77 \times 0.29 =$ -	0.2233
0.77 the area of the section of the stem, and its momentum $0.77 \times 169.76 =$ -	130.7152
5592.27 Sum - - - -	473560.2148

Now $\frac{473560.2148}{5952.27} = 84.68$, the distance of the centre of gravity of the whole section from the aft-side of the stern-post.

III. *Determination of the Centre of Gravity of the third Horizontal Section.*

Distance of the centre of gravity of double the plane $8emG$ from its first ordinate $8e$.

Ordinates.			Double Ord.			1st Factors.	1st Products.			2d Fact.	2d Products.		
Feet.	In.	Pts.	Feet.	In.	Pts.		Feet.	In.	Pts.		Feet.	In.	Pts.
6	7	6	13	3	0	$0\frac{1}{3}$	2	2	6	$0\frac{1}{2}$	6	7	6
11	7	6	23	3	0	1	23	3	0	1	23	3	0
15	1	0	30	2	0	2	60	4	0	1	30	2	0
17	1	3	34	2	6	3	102	7	6	1	34	2	6
18	3	0	36	6	0	4	146	0	0	1	36	6	0
19	3	0	38	6	0	5	192	6	0	1	38	6	0
19	9	0	39	6	0	6	237	0	0	1	39	6	0
20	0	0	40	0	0	7	280	0	0	1	40	0	0
20	0	0	40	0	0	8	320	0	0	1	40	0	0
19	8	3	39	4	6	9	354	4	6	1	39	4	6
19	1	3	38	2	6	10	382	1	0	1	38	2	6
18	1	0	36	2	0	11	397	10	0	1	36	2	0
16	3	9	32	7	6	12	391	6	0	1	32	7	6
13	2	3	26	4	6	13	342	10	6	1	26	4	6
8	4	6	16	9	0	$((3 \times 15)-4) \times \frac{1}{3} =$	114	5	6	$0\frac{1}{2}$	8	4	6
242	5	3	484	10	6		3347	0	6		469	10	6

Hence the distance of the centre of gravity of double the plane $8emG$ from its first ordinate $8e$ is $=$

$\frac{3347 \quad 0 \quad 6}{469 \quad 10 \quad 6} \times 10 \quad 0 \quad 4 = \frac{3347.04}{469.87} \times 10.03 =$ - - -	71.44
Distance of this ordinate from the aft side of the post - - -	13.5
Hence the distance of the centre of gravity of this plane from the aft side of the post is -	84.94
Distance of the centre of gravity of double the trapezium $ARe8$, from its ordinate AR -	8.03
Distance of this ordinate from the aft side of the post - - - -	0.58
Distance of the centre of gravity of this trapezium from the aft side of the post -	8.61
Distance of the centre of gravity of the foremost trapezium from its ordinate Gm -	5.19
Distance of this ordinate from the aft side of the post - - -	153.78
Distance of the centre of gravity of this trapezium from the aft side of the post -	158.97
Distance of the centre of gravity of the section of the post from the aft side of the post -	0.29
Distance of the centre of gravity of the section of the stem from the aft side of the post -	169.76

The

Centre of Gravity.

The areas of these several planes will be found to be as follows:

4712.7961	for that of double the plane $8\,e\,m\,G$, and its momentum $4712.7961 \times 84.94 =$	400304.9007
93.84	the area of double the trapezium $AR\,3\,e\,88$, and its momentum $93.84 \times 8.61 =$	807.9624
131.1	for the area of foremost trapezium, and its momentum $131.1 \times 158.97 =$	20840.967
0.77	the area of the section of the post, and its momentum $0.77 \times 0.29 =$ -	0.2233
0.77	the area of the section of the stem, and its momentum $0.77 \times 169.76 =$ -	130.7152
4939.2761	Sum - - - - - -	422084.7706

Now $\frac{422084.7706}{4939.2761} = 85.45$, the distance of the centre of gravity of the whole section from the aft side of the post.

IV. *Determination of the Centre of Gravity of the Fourth Horizontal Section.*

Distance of the centre of gravity of double the plane $8\,d\,l\,G$ from its first ordinate $8\,d$.

Ordinates. Feet. In. Pts.	Double Ord. Feet. In. Pts.	1. Factors.	1. Products. Feet. In. Pts.	2. Fact.	2. Products. Feet. In. Pts.
3 3 6	6 7 0	$0\frac{1}{6}$	1 1 2	$0\frac{1}{2}$	3 3 6
7 9 0	15 6 0	1	15 6 0	1	15 6 0
11 11 0	23 10 0	2	47 8 0	1	23 10 0
14 8 9	29 5 6	3	88 4 6	1	29 5 6
16 3 0	32 6 0	4	130 0 0	1	32 6 0
17 4 9	34 9 6	5	173 11 5	1	34 9 6
18 1 9	36 3 6	6	217 9 0	1	36 3 6
18 5 0	36 10 0	7	257 10 0	1	36 10 0
18 3 0	36 6 0	8	292 0 0	1	36 6 0
17 10 9	35 9 6	9	322 1 6	1	35 9 6
17 2 6	34 5 0	10	340 10 0	1	34 5 0
15 10 3	31 8 6	11	348 9 6	1	31 8 6
13 6 0	27 0 0	12	324 0 0	1	27 0 0
9 7 6	19 3 0	13	250 3 0	1	19 3 0
5 4 9	10 9 6	$\left((3 \times 15) - 4\right) \times \frac{1}{6}$	73 8 11	$0\frac{1}{2}$	5 4 9
205 7 6	411 3 0		2883 11 0		402 6 9

Hence the distance of the centre of gravity of double the plane $8\,d\,l\,G$ from its first ordinate $8\,d$, is $= \frac{2883\ 11\ 0}{402\ 6\ 9} \times 10\ 0\ 4 = \frac{2883.916}{402.56} \times 10.03 =$ - - - 71.85

Distance of this ordinate from the aft side of the post - - -	13.5
Distance of the centre of gravity of the plane from the aft side of the post - -	85.35
Distance of the centre of gravity of double the trapezium $AR\,d\,8$ from its ordinate AR -	7.89
Distance of this ordinate from the aft side of the post - - -	0.58
Distance of the centre of gravity of the trapezium from the aft side of the post - -	8.47
Distance of the centre of gravity of the foremost trapezium from its ordinate $G\,l$ - -	4.83
Distance of this ordinate from aft side of the post - -	153.78
Distance of the centre of gravity of the trapezium from the aft side of the post - -	158.61
Distance of the centre of gravity of the section of the post from its aft side - -	0.29
Distance of the centre of gravity of the section of the stem from the aft side of the post - -	169.76

The

Centre of Gravity.

The areas of these several planes being calculated, will be as follow:

4037.6768	for that of double the plane $8\,d\,l\,G$, and its momentum $4037.6768 \times 85.35 =$	344615.7149
51.12	the area of double the trapezium $AR\,d\,8$, and its momentum $51.12 \times 8.47 =$ -	432.9804
79.16	the area of the foremost trapezium, and its momentum $79.16 \times 158.61 =$ -	12555.5676
0.77	the area of the section of the post, and its momentum $0.77 \times 0.29 =$ - -	0.2233
0.77	the area of the section of the stem, and its momentum $0.77 \times 169.76 =$ - -	130.7152
4169.4968	Sum - - - - -	357735.2074

Then $\frac{357735.2074}{4169.4968} = 85.80$, the distance of the fourth horizontal section from the aft side of the stem-post.

V. *Determination of the Centre of Gravity of the fifth Horizontal Section.*

Distance of the centre of gravity of double the plane $8\,c\,k\,G$ from its first ordinate $8\,c$.

Ordinates. Feet.	In.	L.	Double Ord. Feet.	In.	L.	1. Factors.	1. Products. Feet.	In.	L.	2. Fact.	2. Products. Feet.	In.	L.
1	9	0	3	6	0	$0\frac{1}{6}$	0	7	0	$0\frac{1}{2}$	1	9	0
4	6	0	9	0	0	1	9	0	0	1	9	0	0
8	3	0	16	6	0	2	33	0	0	1	16	6	0
11	8	3	23	4	6	3	70	1	6	1	23	4	6
13	10	3	27	8	6	4	110	10	0	1	27	8	6
15	3	0	30	6	0	5	152	6	0	1	30	6	0
16	0	3	32	0	6	6	192	3	0	1	32	0	6
16	5	0	32	10	0	7	229	10	0	1	32	10	0
16	3	0	32	6	0	8	260	0	0	1	32	6	0
15	9	0	31	6	0	9	283	6	0	1	31	6	0
14	10	0	29	8	0	10	296	8	0	1	29	8	0
12	10	3	25	8	6	11	282	9	6	1	25	8	6
9	8	9	19	5	6	12	233	6	0	1	19	5	6
6	1	6	12	3	0	13	159	3	0	1	12	3	0
3	3	0	6	6	0	$\left((3 \times 15) - 4\right) \times \frac{1}{6}$	44	5	0	$0\frac{1}{2}$	3	3	0
166	6	3	333	0	7		2358	3	0		328	0	6

Hence the distance of the centre of gravity of double the plane $8\,c\,k\,G$ from its first ordinate is $\frac{2358\ \ 3\ \ 0}{328\ \ 0\ \ 6}$

$\times 10\ \ 0\ \ 4 = \frac{2358.25}{328.04} \times 10.03 =$ - - - - - - 72.10

Distance of this ordinate from the aft side of the post - - - -	13.50
Distance of the centre of gravity of the plane from the aft side of the post - - -	85.60
Distance of the centre of gravity of double the trapezium $AR\,c\,8$ from its ordinate AR - -	7.42
Distance of this ordinate from the aft side of post - - - - -	0.58
Distance of centre of gravity of trapezium from aft side of the post - - -	8.00
Distance of the centre of gravity of the foremost trapezium from its ordinate $G\,k$ - -	4.22
Distance of this ordinate from the aft side of post - - - - -	153.78
Distance of the centre of gravity of the foremost trapezium from the aft side of the post -	158.00
Distance of the centre of gravity of the section of the post from the aft side of post - -	0.29
Distance of the centre of gravity of the section of the stem from the aft side of post - -	169.76

The

Centre of Gravity.

The areas of these several planes being calculated, will be as follow.

3290.2412	for the area of double the plane $8\,c\,k\,G$, and its momentum $3290.2412 \times 85.6 =$	281644.6467
31.21	the area of double the trapezium $AR\,c\,8$, and its momentum $31.21 \times 8 =$	249.68
42.43	the area of the foremost trapezium, and its momentum $42.43 \times 158 =$	6703.94
0.77	the area of the section of the post, and its momentum $0.77 \times 0.29 =$	0.2233
0.77	the area of the section of the stem, and its momentum $0.77 \times 169.76 =$	130.7152
3365.4212	Sum	288729.2052

Now $\frac{288729.2052}{3365.4212} = 85.79$, the distance of the centre of gravity of the whole section from the aft side of the stern.

VI. *Determination of the Centre of Gravity of the sixth Horizontal Section.*

Distance of the centre of gravity of double the plane $8\ b\ i\ G$ from its first ordinate $8\ b$.

Ordinates. Feet.	In.	L.	Double Ord. Feet.	In.	L.	1. Factors.	1. Products. Feet	In.	L.	2. Fact.	2. Products. Feet.	In.	L.
1	0	0	2	0	0	$0\frac{1}{6}$	0	4	0	$0\frac{1}{2}$	1	0	0
2	5	0	4	10	0	1	4	10	0	1	4	10	0
4	5	0	8	10	0	2	17	8	0	1	8	10	0
7	3	6	14	7	0	3	43	9	0	1	14	7	0
10	1	9	20	3	6	4	81	2	0	1	20	3	6
12	1	3	24	2	6	5	121	0	6	1	24	2	6
13	3	0	26	6	0	6	159	0	0	1	26	6	0
13	9	9	27	7	6	7	193	4	6	1	27	7	6
13	7	0	27	2	0	8	217	4	0	1	27	2	0
12	8	0	25	4	0	9	228	0	0	1	25	4	0
10	6	6	21	1	0	10	210	10	0	1	21	1	0
7	1	0	14	2	0	11	155	10	0	1	14	2	0
4	7	3	9	2	6	12	110	6	0	1	9	2	6
2	10	6	5	9	0	13	74	9	0	1	5	9	0
1	6	9	3	1	6	$\times\left((3 \times 15) - 4\right) \times \frac{1}{6}$	21	4	3	$0\frac{1}{2}$	1	6	9
117	4	3	234	8	6		1639	9	3		232	1	9

Hence the distance of the centre of gravity of double the plane $8\ b\ v\ G$ from its first ordinate $8\ b$ is

$\frac{1639\ \ 9\ \ 3}{232\ \ 1\ \ 3} \times 10\ \ 0\ \ 4 = \frac{1639.77}{232.14} \times 10.03 =$	70.84
Distance of this ordinate from aft side of post	13.50
Hence the distance of the centre of gravity of the plane from the aft side of the post is	84.34
Distance of the centre of gravity of the trapezium $AR\ b\ 8$ from its ordinate AR	6.88
Distance of this ordinate from the aft side of the post	0.58
Distance of the centre of gravity of the trapezium from the aft side of the post	7.46
Distance of the centre of gravity of the foremost trapezium from the ordinate $G\ i$	2.92
Distance of this ordinate from the aft side of post	153.78
Distance of the centre of gravity of this trapezium from the aft side of the post	156.70
Distance of the centre of gravity of the section of the post from its aft side	0.29
Distance of the centre of gravity of the section of the stem from the aft side of the post	169.76

The areas of these planes will be found to be as follow:

2328.3642	for that of double the plane $8\ b\ i\ G$, and its momentum $2328.3642 + 84.34 =$	196374.2366
21.52	for the area of double the trapezium $AR\ b\ 8$, and its momentum $21.52 \times 7.46 =$	160.5392
15.04	the area of the foremost trapezium, and its momentum $15.04 \times 156.7 =$	2356.7680
0.77	the area of the section of the post, and its momentum $0.77 \times 0.29 =$	0.2233
0.77	the area of the section of the stem, and its momentum $0.77 \times 169.76 =$	130.7152
2366.4642	Sum	199022.4823

Now

Centre of Gravity.

Now $\frac{199022.4823}{2366.4642} = 84.1$, the distance of the centre of gravity of the whole from the aft side of the post.

VII. *Determination of the Centre of Gravity of the seventh Horizontal Section.*

Distance of the centre of gravity of double the plane 8 *a h* G from its first ordinate 8 *a*.

Ordinates. Feet. In. Lin.	Double Ord. Feet. In. L.	1. Factors.	1. Products. Feet. In. Lin.	2. Fact.	2 Products. Feet. In. Lin.
0 8 0	1 4 0	$0\frac{1}{6}$	0 2 8	$0\frac{1}{2}$	0 8 0
1 1 6	2 3 0	1	2 3 0	1	2 3 0
1 7 6	3 3 0	2	6 6 0	1	3 3 0
1 10 9	3 9 6	3	11 4 6	1	3 9 6
2 1 3	4 2 6	4	16 10 0	1	4 2 6
2 1 0	4 2 0	5	20 10 0	1	4 2 0
1 10 9	2 9 6	6	22 9 0	1	3 9 6
1 8 0	3 4 0	7	23 4 0	1	3 4 0
1 1 0	2 2 0	8	17 4 0	1	2 2 0
0 9 0	1 6 0	9	13 6 0	1	1 6 0
0 8 0	1 4 0	10	13 4 0	1	1 4 0
0 8 0	1 4 0	11	14 8 0	1	1 4 0
0 8 0	1 4 0	12	16 0 0	1	1 4 0
0 8 0	1 4 0	13	17 4 0	1	1 4 0
0 8 0	1 4 0	$((3\times15)-4)\times\frac{1}{6}$	9 1 4	$0\frac{1}{2}$	0 8 0
18 2 9	36 5 6		205 4 6		35 1 6

Hence the distance of the centre of gravity of double this plane from its first ordinate is $\frac{205\ 4\ 6}{35\ 1\ 6}\times 10\ 0\ 4$

$=\frac{205.37}{35.12}\times 10.83 =$ - - - .	58.65
The distance of this ordinate from aft side of post = - - - - -	13.50
Hence the distance of the centre of gravity of this plane from the aft side of the post is	72.15
Distance of the centre of gravity of double the rectangle AR *a* 8 from its ordinate AR	6.45
Distance of this ordinate from the aft side of the post - - - - -	0.58
Distance of the centre of gravity of this rectangle from the aft side of the post	7.03
Distance of the centre of gravity of the foremost rectangle from its ordinate 7′ 7 *e* 7′	1.25
Distance of this ordinate from the aft side of the post - - - -	153.78
Distance of the centre of gravity of this rectangle from the aft side of the post	155.03
Distance of the centre of gravity of the section of the post from its aft side	0.29
Distance of the centre of gravity of the section of the stem from the aft side of the post - - - - -	169.76

Now, the areas of these several plans being calculated will be as follows.

352.2536, the area of double the plan 8*ah*G, and its momentum $352.2536\times72.15=$	25415 9 2
17.1570, the area of double the rectangle AR *a* 8, and its momentum $17.1570\times7.03=$	120.6137
3.3250, the area of the foremost rectangle, and its momentum $3.3250\times155.03=$	515.4747
0.77, the area of the section of the post, and its momentum $0.77\times0.29=$	0.2233
077, the area of the section of the stem and its momentum $0.77\times166.76=$	130.7152
374.2756 Sum	26182.1242

Then $\frac{26182.1242}{374.2756} = 69.95$, the distance of the centre of gravity of the whole section from the aft side of the post.

VIII. *Determination of the Centre of Gravity of the eighth Plane.*

This plane is equal in length to the seventh horizontal plane, and its breadth is equal to that of the keel. The distance between the seventh and eighth planes is three feet, but which is here taken equal to 2 feet 11½ inches.

Distance

Centre of Gravity.

Diſtance between the aft ſide of the poſt and the firſt ordinate - - -	13.5
Fourteen intervals between the fifteen ordinates, each interval being 10.03 feet	140.42
Diſtance of the laſt ordinate from the fore foot	2.2
Hence the length of the eighth plane is	156.12
Which multiplied by the breadth	1.33
The product is the area of this plane	208.
The diſtance of its centre of gravity from the aft ſide of the poſt, being equal to half its length, is - - -	78.06

The centres of gravity of theſe eight planes being found, the diſtance of the centre of gravity of the bottom of the ſhip from the aft ſide of the poſt, and alſo its altitude, may from thence be eaſily determined.

From the principles already explained, the diſtance of the centre of gravity of the bottom from the aft ſide of the poſt, is equal to the ſum of the momentums of an infinite number of horizontal planes, divided by the ſum of theſe planes, or, which is the ſame, by the ſolidity of the bottom. As, however, we have no more than eight planes, we muſt therefore conceive their momentums as the ordinates of a curve, whoſe diſtances may be the ſame as that of the horizontal planes. Now the ſum of theſe ordinates minus half the ſum of the extreme ordinates being multiplied by their diſtance, gives the ſurface of the curve; of which any ordinate whatever repreſents the momentum of the horizontal plane at the ſame altitude as theſe ordinates; and the whole ſurface will repreſent the ſum of the momentums of all the horizontal planes.

Hor. Planes.	Fact.	Products.	Momentums.	Fact.	Products.
5974.16	0½	2987.08	503037.73	0½	251518.86
5592.27	1	5592.27	473560.21	1	473560.21
4939.27	1	4939.27	422084.77	1	422084 77
4169.50	1	4169.50	357735.21	1	357735.21
3365.42	1	3365 42	288729.20	1	288729.20
2366.46	1	2366.46	199022.48	1	199022.48
374.27	1	374.27	21682.12	1	21682.12
208.00	0½	104.00	16236.48	0½	8118.24
		23898.27			2022451.09

Now $\frac{2022451.09}{23898.27}=84.63$, the diſtance of the centre of gravity of the bottom of the ſhip from the aft ſide of the poſt.

The height of the centre of gravity of the bottom above the lower edge of the keel may be determined by the ſame principles. Thus,

To one-ſixth of the lowermoſt horizontal ſection add the product of one-ſixth of the uppermoſt ſection by three times the number of ſections minus four the ſecond ſection in aſcending, twice the third, three times the fourth, &c.; and to half the ſum of the extreme planes add all the intermediate ones. Now the firſt of theſe ſums, multiplied by the diſtance between the planes or ſections, and divided by the ſecond ſum, gives the altitude of the centre of gravity of the bottom of the ſhip above the lower edge of the keel as required.

Hor. Planes.	1ſt Fact.	1ſt Products.	2d Fact.	2d Products.
208.00	0⅙	34.67	0½	104.00
374.27	1	374.27	1	374.27
2366.46	2	4732 92	1	2366.46
3365.42	3	10096.26	1	3365.42
4169.50	4	16678.00	1	4169.50
4939.27	5	24696.35	1	4939.27
5592.27	6	33553.62	1	5592.27
5974.16	$\left((3\times 8)-4\right)\times\frac{1}{6}$	19913.87	0½	2987 08
		110079.96		23898.27

Now $\frac{110079.96}{23898.27}\times 2.95=13.588$, the height of the centre of gravity of the bottom of the ſhip above the lower edge of the keel.

We have now found the diſtance of the centre of gravity of the bottom of the ſhip from the aft ſide of the poſt, and its altitude above the lower edge of the keel. Hence the ſhip being ſuppoſed in an upright poſition, this centre of gravity will neceſſarily be in the vertical longitudinal ſection which divides the ſhip into two equal and ſimilar parts; the poſition of this centre is therefore determined.

70 Determination of the height of the metacenter above the centre of gravity.

It now remains to find the height of the metacenter above the centre of gravity; the expreſſion for this altitude, as found in Chap. III. is $\frac{\frac{2}{3}\int y^3 x}{V}$; which we ſhall now apply to determine the metacenter of the ſhip of 74 guns, whoſe centre of gravity we have already found.

Ord. of the Plane of Floatation.				*Cub. of Ordinates.*
Feet.	Inches.		Feet and dec. of Foot.	
14	9	0	14.7	3209.046
17	1	6	17.1	5000.211
18	9	0	18.7	6591.797
19	10	0	19.8	7762.392
20	7	6	20.6	8741.816
21	1	9	21.2	9595.703
21	6	3	21.5	9938 375
21	7	9	21.7	10289.109
21	7	9	21.7	10289.109
21	7	6	21.7	10289.109
21	4	0	21.3	9663.597
20	10	6	20.9	9129.329
19	9	0	19.7	7703.734
17	4	6	17.4	5268.024
13	1	3	13.1	2248.091
291	1	3	291.1	115719.442

Ordinate at 10.03 feet abaft the ordinate $8g$, $=4$, of which the cube is 64, and $64\times\frac{1}{2}$ - -	32.
Ordinate at 10.03 feet afore the ordinate $G\,o=6$, cube of which is 216 and $216\times\frac{1}{2}$ - -	108.
Sum - - -	115859.442
Diſtance between the ordinates -	10.03
Product - -	1162070.20326

Product

Centre of Gravity.

Product			1162070.20326
Half the cube of the aftermost ordinate	32.		
Half the cube of the thickness of the stem	0.14		
Sum	32.14		
Distance between the ordinates	3.0		
Product			96.42
Half the cube of the foremost ordinate	108.		
Half the cube of the thickness of the stem	.14		
Sum	108.14		
Distance between the ordinates	5.5		
Product			594.77
$\int y^3 x$			1162761.39326
$2\int y^3 x$			2325522.78652
$\frac{2}{3}\int y^3 x$			775174.26217

The solidity of the bottom is $2527\frac{1}{4}$ tons $=70018.67$ cubic feet: hence $\frac{\frac{2}{3}\int y^3 x}{V}=\frac{77517.26}{70018.67}=11.07$ feet, the altitude of the metacenter above the centre of gravity of the bottom of the ship.

APPENDIX.

When a ship is built, she must be fitted with masts, yards, sails, ropes, and blocks, or, in other words, she must be *rigged* before she can go to sea. To complete this article, it may therefore be thought necessary to treat of the art of rigging vessels; but we have elsewhere (see *Mast-Rigging*, Rope-Making, and Sail) shown how the several parts of a ship's rigging are made; and the art of putting them properly together, so as to make the ship best answer the purpose for which she is intended, depends upon a just knowledge of the impulse and resistance of fluids, and of the theory and practice of seamanship. (See *Resistance of Fluids* and Seamanship). Nothing, therefore, of the subject is left to us here, except we were to state in few words the progressive method of rigging ships; but there is no one undeviating mode which is pursued, as the nature of the operation is such that all the parts of it may be advancing at the same time. We shall therefore take our leave of *ships* and *ship-building* with a few general observations on *sail-making*, and refer our readers for farther information to the very elegant work on *the Elements and Practice of Rigging and Seamanship* in two volumes quarto.

Sails are made of canvas, of different textures, and are extended on or between the masts, to receive the wind that forces the vessel through the water. They are quadrilateral or triangular, as has been elsewhere described, and are cut out of the canvas cloth by cloth. The width is governed by the length of the yard, gaff, boom, or stay; the depth by the height of the mast. In the valuable work to which we have just referred, the following directions are given for cutting sails. "The width and depth being given, find the number of cloths the width requires, allowing for seams, tabling on the leeches, and slack cloth; and, in the depth, allow for tabling on the head and foot. For sails cut square on the head and foot, with gores only on the leeches, as some topsails, &c. the cloths on the head, between the leeches, are cut square to the depth; and the gores on the leeches are found by dividing the depth of the sail by the number of cloths gored, which gives the length of each gore. The gore is set down from a square with the opposite selvage; and the canvas being cut diagonally, the longest gored side of one cloth makes the shortest side of the next; consequently, the first gore being known, the rest are cut by it. In the leeches of topsails cut hollow, the upper gores are longer than the lower ones; and in sails cut with a roach leech, the lower gores are longer than the upper ones. This must be regulated by judgment, and care taken that the whole of the gores do not exceed the depth of the leech. Or, by drawing on paper the gored side of the sail, and delineating the breadth of every cloth by a convenient scale of equal parts of an inch to a foot, the length of every gore may be found with precision. Sails, gored with a sweep on the head or the foot, or on both, have the depth of their gores marked on the selvage, from the square of the given depth on each cloth, and are cut as above; the longest selvage of one serving to measure the shortest selvage of the next, beginning with the first gored cloth next the middle in some sails, and the first cloth next to the mast leech in others. For those gores that are irregular no strict rule can be given; they can only be determined by the judgement of the sail-maker, or by a drawing.

Appendix.

"In the royal navy, mizen topsails are cut with three quarters of a yard hollow in the foot; but, in the merchant service, top and topgallant sails are cut with more or less hollow in the foot. Flying jibs are cut with a roach curve on the stay, and a three-inch gore in each cloth, shortening from the tack to the clue. Lower studding-sails are cut with square leeches, and topmast and topgallant-mast studding sails with goring leeches.

Elements and Practice of Rigging and Seamanship, vol. i. p. 91.

"The length of reef and middle bands is governed by the width of the sail at their respective places; the leech-linings, buntline-cloths, top-linings, mast-cloths, and corner-pieces, are cut agreeably to the depth of the sail; each cloth and every article should be properly marked with charcoal, to prevent confusion or mistake. Sails that have bonnets are cut out the whole depth of the sail and bonnet included, allowing enough for the tablings on the foot of the sail and head and foot of the bonnet. The bonnet is cut off after the sail is sewed together. If a drabler is required, it is allowed for in the cutting out the same as the bonnet.

When the cloth is thus properly cut, the different pieces are to be joined together in the form of a sail; and for doing this properly we have the following directions in the work already quoted. "Sails have a double flat seam, and should be sewed with the best English made twine of three threads, spun 360 fathoms to the pound, and have from one hundred and eight to one hundred and sixteen stitches in every yard in length. The twine for large sails, in the royal navy, is waxed

Appendix. by hand, with genuine bees wax, mixed with one fixth part of clear turpentine; and, for fmall fails, in a mixture made with bees wax, 4 lb. hogs lard 5 lb. and clear turpentine 1 lb. In the merchant fervice, the twine is dipped in tar (L), foftened with a proper proportion of oil.

" It is the erroneous practice of fome failmakers not to few the feams any farther than where the edge is creafed down for the tabling; but all fails fhould be fewed quite home to the end, and, when finifhed, fhould be well rubbed down with a rubber. In the merchant fervice feams are fometimes made broader at the foot than at the head, being ftronger. Broad feams are not allowed to be made on courfes, in the royal navy, but goring leeches are adopted in lieu of them. Boom-mainfails and the fails of floops generally have the feams broader at the foot than at the head. The feams of courfes and topfails are ftuck or ftitched up, in the middle of the feams, along the whole length, with double feaming twine; and have from 68 to 72 ftitches in a yard. In the merchant fervice it is common to ftick the feams with two rows of ftitches, when the fail is half worn, as they will then laft till the fail is worn out.

" The breadth of the feams of courfes, topfails, and other fails, in the royal navy, to be as follow, viz. courfes and topfails, for 50 gun fhips and upwards, one inch and a half, and for 44 gun fhips and under, one inch and a quarter, at head and foot; all other fails, one inch at head and foot.

" The tablings of all fails are to be of a proportionable breadth to the fize of the fail, and fewed at the edge, with 68 to 72 ftitches in a yard. Thofe for the heads of main and fore courfes to be four to fix inches wide; for fprit courfes and mizens, drivers, and other boom fails, 3 to 4 inches wide; for topfails, 3 inches to 4 inches and a half; topgallant and fprit topfails, 3 inches; royal fails, 2 inches and a half; jib and other flayfails, 3 inches to 4 inches and a half, on the ftay or hoift; and for ftudding fails, 3 inches to 4 inches on the head. Tablings on the foot and leeches of main and fore courfes to be 3 inches to 5 inches broad; fprit courfe and topfails, 3 inches; topgallant and fprit topfails, 2 inches and a half; royals, 2 inches; fore leeches of mizen, driver, and other boomfails, 3 inches and a half to 4 inches; after leech, 3 inches; and on the foot 2 or 3 inches. Tablings on the after leech of jibs and other ftayfails to be from 2 to 3 inches broad; and, on the foot, 2 to 2 inches and a half: on ftudding fail leeches one inch and a half to two inches and a half; and on the foot, from one to two inches.

" Main and fore courfes are lined on the leeches, from clue to earing, with one cloth feamed on and ftuck or ftitched in the middle, and have a middle band half way between the lower reef band and the foot, alfo four buntline cloths, at equal diftances between the leeches, the upper ends of which are carried under the middle band, that the lower fide of the band may be tabled upon or fewed over the end of the buntline pieces. They have likewife two reef bands; each in breadth one third of the breadth of the canvas; the upper one is one fixth of the depth of the fail from the head, and the lower band is at the fame diftance from the upper one; the ends go four inches under the leech linings, which are feamed over the reef bands. All linings are feamed on, and are ftuck with 68 to 72 ftitches in a yard. Appendix.

" Main, fore, and mizen, topfails have leech linings, maft and top linings, buntline cloths, middle bands and reef bands. The leech linings are made of one breadth of cloth, fo cut and fewed as to be half a cloth broad at the head, and a cloth and a half broad at the foot; the piece cut out being half the breadth of the cloth at one end, and tapering to a point at the other. The middle bands are put on half way between the lower reef and foot, the buntline cloths join the top-linings, and the buntline cloths and top-linings are carried up to the lower fide of the middle band, which is tabled on them. The maft lining is of two cloths, and extends from the foot of the fail to the lower reef, to receive the beat or chafe of the maft. The middle band is made of one breadth of canvas, of the fame number as the top lining. It is firft folded and rubbed down, to make a creafe at one third of the breadth; then tabled on the felvage, and ftuck along the creafe; then turned down, and tabled and ftuck through both the double and fingle parts, with 68 to 72 ftitches in a yard. It is the opinion of many, that middle bands fhould not be put on until the fail is half worn.

" Main and fore topfails have three and fometimes four reef bands from leech to leech, over the leech linings; the upper one is one eighth of the depth of the fail from the head, and they are the fame diftance afunder in the royal navy, but more in the merchant fervice. The reef bands are each of half a breadth of canvas put on double; the firft fide is ftuck twice, and the laft turned over, fo that the reef holes may be worked upon the double part of the band, which is alfo ftuck with 68 to 72 ftitches in a yard.

" The top-lining of topfails is of canvas, N° 6 or 7. The other linings of this, and all the linings of other fails, fhould be of the fame quality as the fails to which they belong.

" Top-linings and maft cloths are put on the aft fide, and all other linings on the fore fide, of fails. Mizens are lined with one breadth of cloth from the clue five yards up the leech, and have a reef band fewed on, in the fame manner as on other fails, at one fifth the depth of the fail from the foot; they have alfo a nock-piece and a peek-piece, one cut out of the other, fo that each contains one yard. Mizen topfails of 50 gun fhips and upwards have three reefs, the upper one is one eighth of the depth of the fail from the head, and the reefs are at the fame diftance afunder. Mizen topfails of fhips of 44 guns and under have two reefs one feventh part of the depth of the fail afunder, the upper one being at the fame diftance from the head. Main and main top-ftudding fails have each one reef, at one eighth of the depth of the fail from the head. Reef bands fhould not be put on until the fail is fewed up, a contrary practice being very erroneous. Lower ftay-fails,

(L) The dipping of the twine in tar, we are perfuaded, is a very bad practice, for the reafon affigned in ROPE-MAKING. See that article, N° 32.

Fig. 1.

PIECES of the HULL.

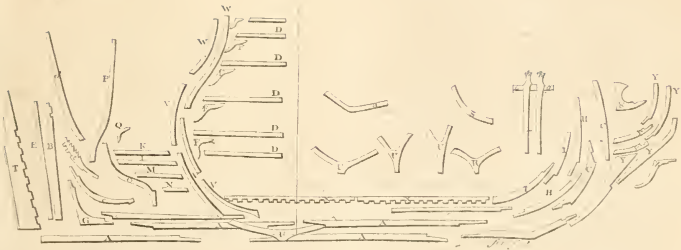
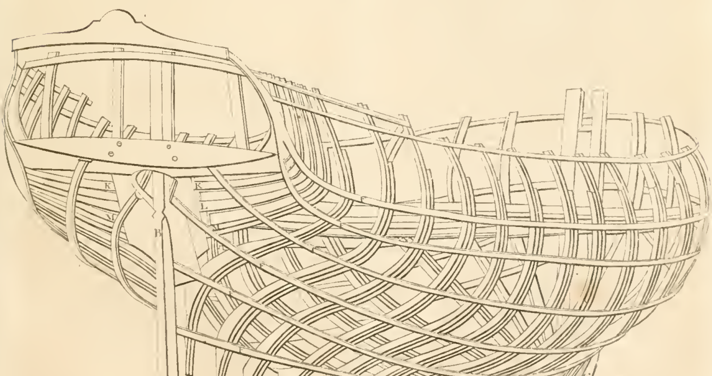


Fig. 2.

FRAMES of a SHIP.



SHIP-BUILDING.

Plate CCCCLXXXV

Fig. 3.

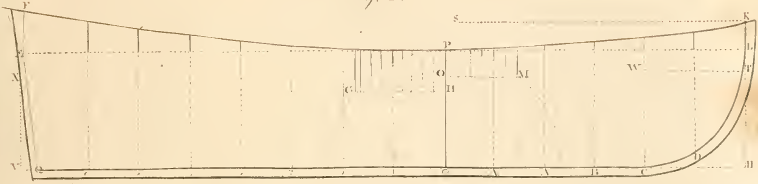


Fig. 4.

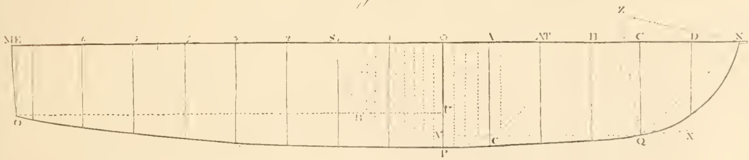


Fig. 5.

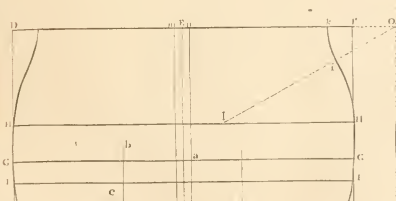


Fig. 6.

Fig. 7.

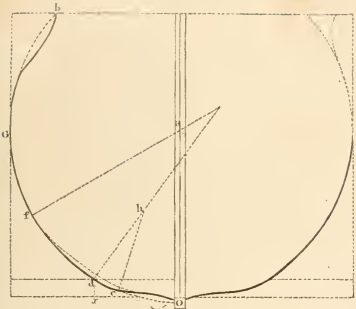


Fig. 8.

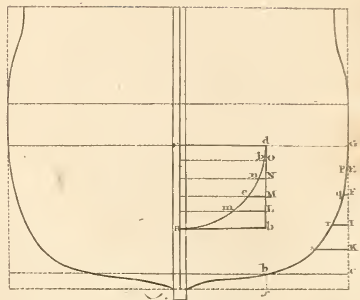


Fig. 9.

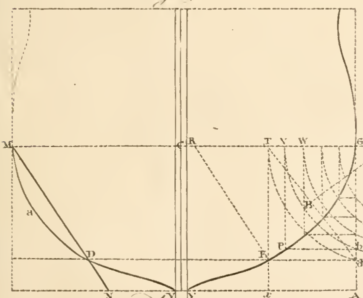


Fig. 10.

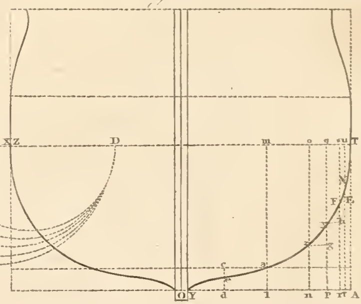


Fig. 11.

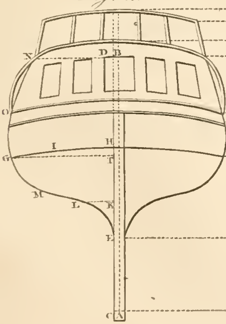
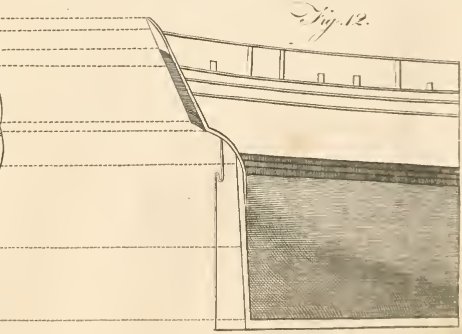
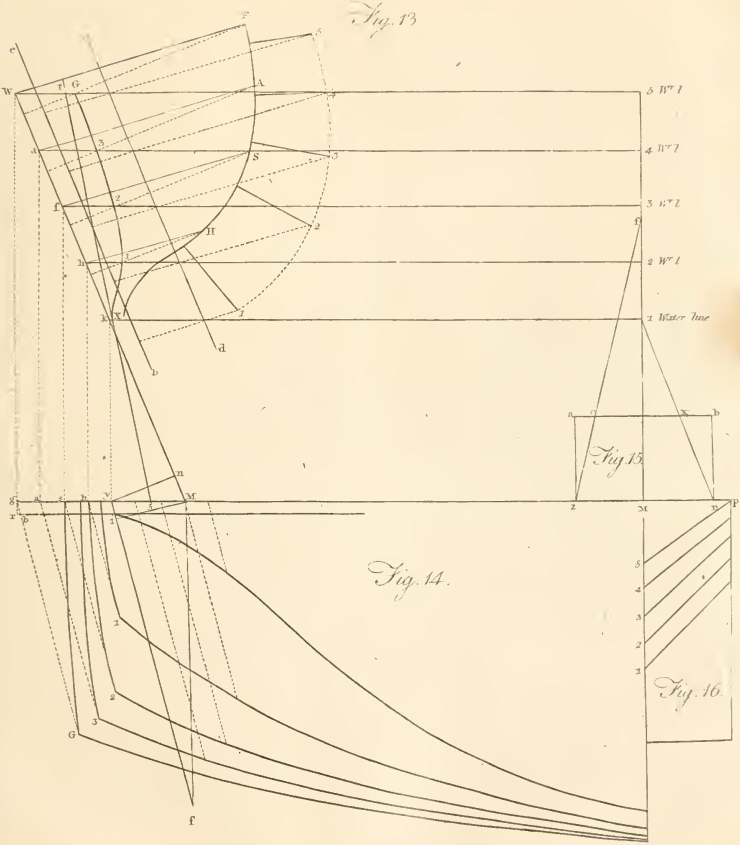


Fig. 12.



R. Pain Sculp.



N. Tram Sculp.

Fig. 17.

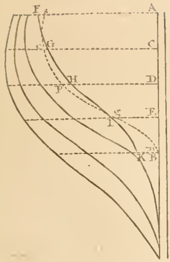


Fig. 18.

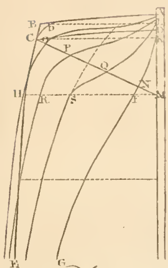


Fig. 19.

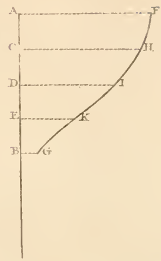
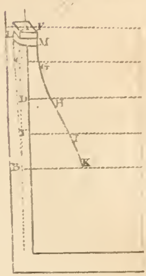


Fig. 20.



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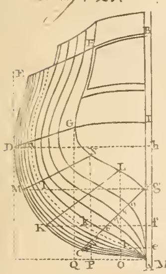

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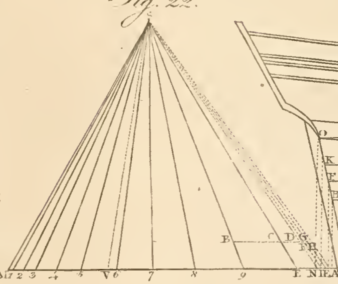


Fig. 23.

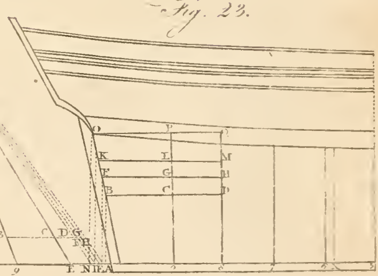


Fig. 24.

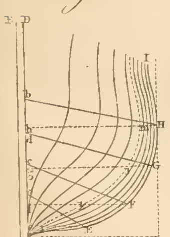


Fig. 25.

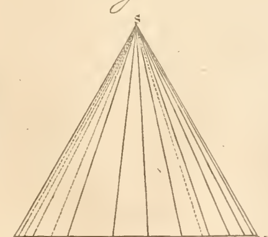
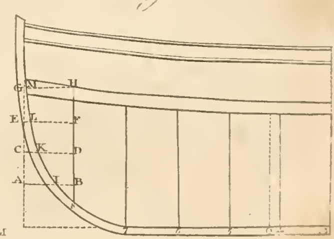


Fig. 26.



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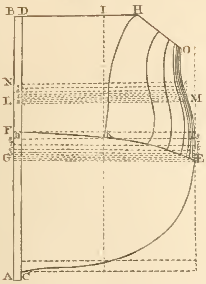

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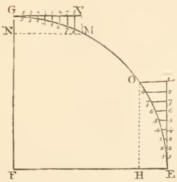

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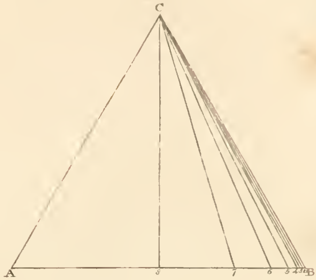

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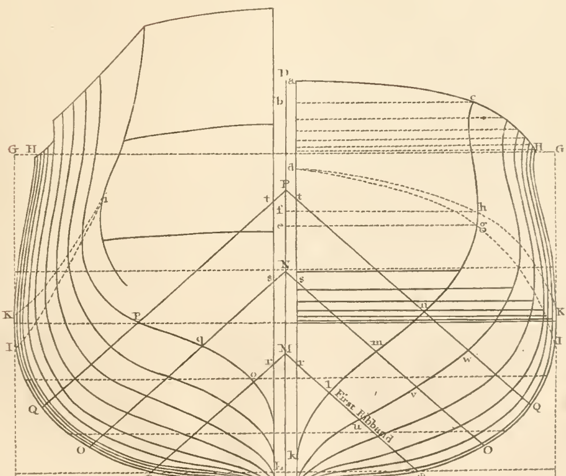

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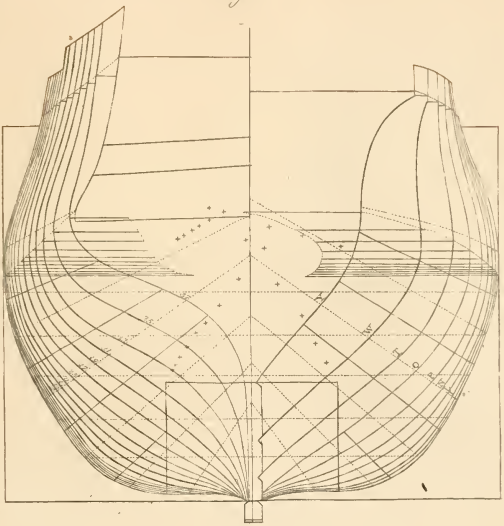
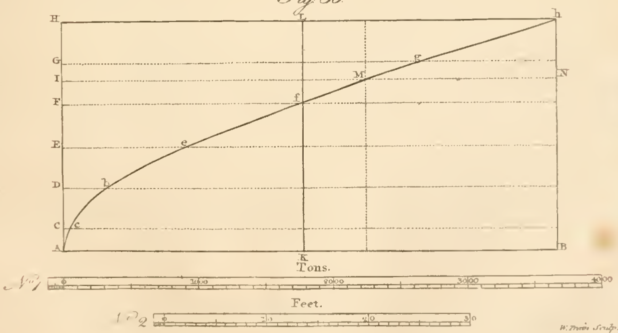


Fig. 36.



W. Lowry Sculp!

Fig. 37.

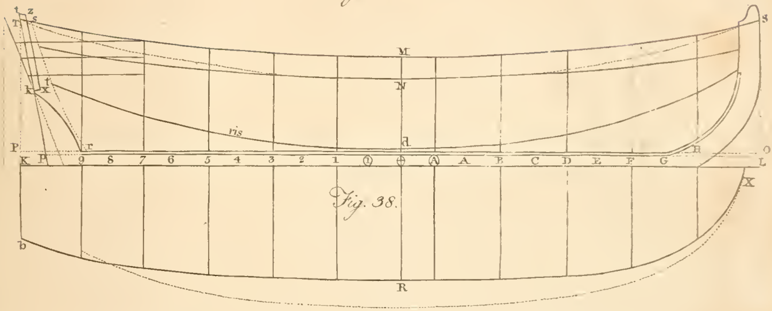


Fig. 38.

Fig. 39.

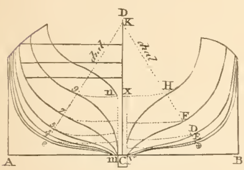
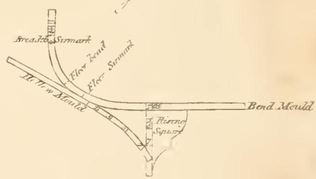


Fig. 40.



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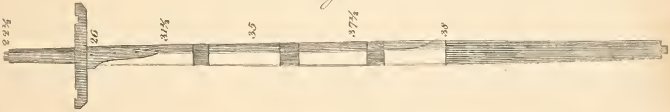


Fig. 42.

Fig. 43.

Fig. 44.

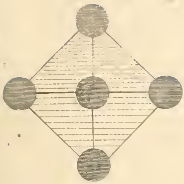
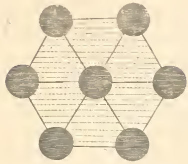


Fig. 45.



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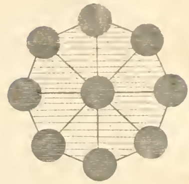

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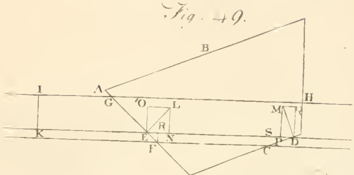


Fig. 47.

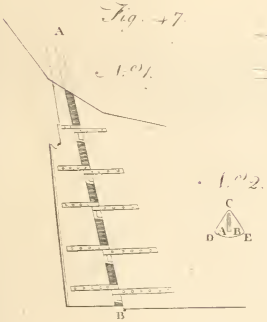


Fig. 50.

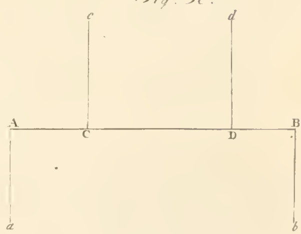
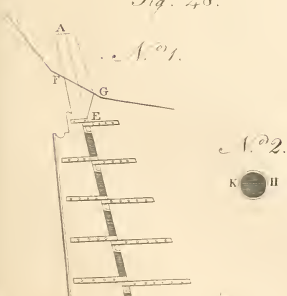


Fig. 48.



BOSWELL'S improved CAPSTAN.

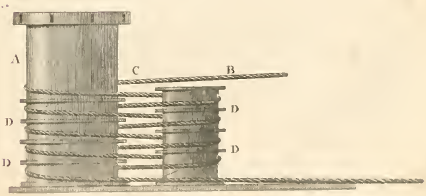


Fig. 51.

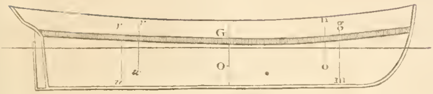


Fig. 52.

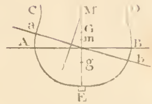


Fig. 53.

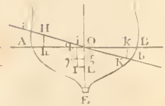


Fig. 54.

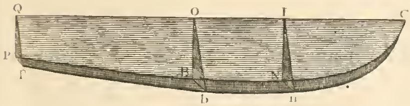


Fig. 55.

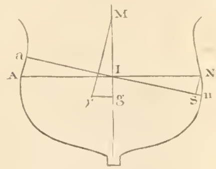


Fig. 56.

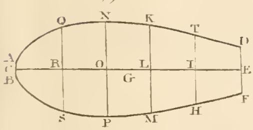


Fig. 57.

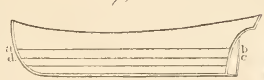


Fig. 58.

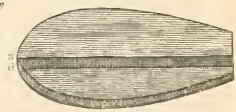
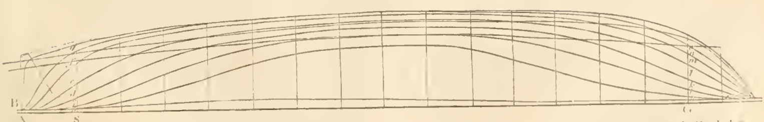


Fig. 59.



E. Mitchell sculp.

Appendix. sails, fore top and main top staysails, and flying jibs, have clue-pieces two yards long. Square tack staysails, have half a breadth of cloth at the fore part, with a clue-piece containing two yards, and a peck-piece, containing one yard.

"Sails have two holes in each cloth, at the heads and reefs of courses, topsails, and other square sails; one hole in every yard in the stay of flying jibs, and one in every three quarters of a yard in the stays of square tack and other staysails. These are made by an instrument called a *pegging awl*, or a stabber, and are fenced round by stitching the edge to a small grommet, made with log or other line; when finished, they should be well stretched or rounded up by a pricker or a marline spike. Reef and head holes of large sails have grommets of twelve-thread line, worked round with 18 to 21 stitches; smaller sails have grommets of nine-thread line, with 16 to 18 stitches, or as many as shall cover the line, and smaller holes in proportion. The holes for marling the clues of sails and the top brims of topsails have grommets of log-line, and should have from 9 to 11 stitches; twelve holes are worked in each cloth. Main courses have marling holes from the clue to the lower bow line cringle up the leech, and from the clue to the first buntline cringle on the foot. Fore courses have marling holes one eighth of the depth of the sail up the leech, and from the clue to the first buntline cringle at the foot. Main and fore topsails have marling holes three feet each way from the clue and at the top-brims. Spritsails, mizen topsails, lower staysails, main and fore top staysails, and jibs, have marling holes two feet each way from the clues. All other sails are sewed home to the clues. Marling holes of courses are at three fourths of the depth of the tablings at the clues from the rope, and those of topsails are at half the depth of the tablings at the clues and top brim from the rope."

The rope, which is sewed on the edges of sails to prevent their rending, and which is called *bolt-rope*, should be well made of fine yarn, spun from the best Riga rhine hemp well topt, and sewed on with good English made twine of three threads, spun 200 fathom to the pound; the twine in the royal navy is dipped in a composition made with bees-wax, 4 lbs. hogs lard 5 lbs. and clear turpentine one pound; and in the merchant service, in tar softened with oil. They should be stoved in a stove by the heat of a flue, and not in a baker's oven or a stove tub; and tarred in the best Stockholm tar. The flexibility of them should be always considered, in taking in the slack, which must rest on the judgment of the sailmaker. Appendix.

"Bolt ropes of courses, topsails, and all other sails, should be neatly sewed on through every buntline of the rope; and, to avoid stretching, the rope must be kept tightly twisted while sewing on, and care taken that neither too much nor too little slack is taken in; they are to be cross stitched at the leeches every twelve inches in length; at every seam, and in the middle of every cloth at the foot, with three cross-stitches: four cross-stitches should be taken at all beginnings and fastenings off; the first stitch given twice, and the last three times. Small sails have two cross stitches at every seam, and three at every fastening off.

"On main and fore courses two inches slack cloth should be allowed in the head and foot, and one inch and a half in the leeches, in every yard in length. Topsails are allowed 3 inches slack in every cloth in the foot, one inch and a half in every yard in the leech, and two inches in every cloth left open in the top brim. Mizen courses have two inches slack in every yard in the foremost leech, but none in the after leech or foot. Spritsail courses have no slack cloth. Jibs have four inches slack in every yard in the stay, one inch in every cloth in the foot, and none in the leech. Staysails have three inches slack in every yard in the stay, one inch in every cloth in the foot, but none in the leech. Topgallant sails have two inches slack in every cloth in the foot, and one inch in every yard in the leech. Studding sails have an inch and a half slack in every yard in goring leeches, but no slack in square leeches, and one inch in every cloth in the head and foot."

These directions for sailmaking, we trust may be useful. They are indeed very general, but the sailmaker will find every instruction that he can want in the *Elements of Rigging and Seamanship*, a work which we therefore recommend to his attention.

Ship. *SHIP's Form Gauge*, an instrument recommended by Mr Hutchinson as fit to ascertain any alteration in the bottom of a ship, by its hogging or sagging; and also to regulate the stowage of a ship.

"All ships (says he) of any consequence are built with staunchions fixed from the kelson to the middle of all the lower-deck beams fore and aft, in order to support them in their exact, regular height, as well as the whole frame of the ship in the regular form in which she was built upon the stocks; yet notwithstanding these staunchions, it is proved from experience that our ships bottoms, hitherto, by the pressure of water, and improper stowage, have generally been hogged upwards, or sagged downwards, and most about the midship frame or main body of the ship, which is commonly about the fore part of the main hatchway; which naturally makes it the best place at which to fix the ship's form gauge, where either the hogging or sagging of her bottom may be observed and seen soonest and best, to regulate the stowage of heavy materials to the greatest advantage, so as to keep her bottom nearly in the same form in which she was built. Ship.

"The gauge I recommend is nothing more than a narrow plate of iron divided into inches and quarters like the slide of a carpenter's rule. Let this be fixed to the after side of the staunchion now mentioned, with its upper end projecting two or three inches above the staunchion; a groove being cut out for it in the after side of the lower-deck beam, and a mark being made (when the ship is on the stocks) at the part of the beam which corresponds to the 0 on the gauge. When the ship alters in her shape, the gauge will slide up and down

Ship.

down in this groove, and the quantity of hogging or fagging will be pointed out on the gauge by the mark on the beam. The ftowage may then be fo managed as to bring this mark to coincide again with the o, or to approach it as near as we fee neceffary."

SHIP-Money, was an impofition charged upon the ports, towns, cities, boroughs, and counties of this realm, in the reign of King Charles I. by writs, commonly called *fhip-writs*, under the great feal of England, in the years 1635 and 1636, for the providing and furnifhing of certain fhips for the king's fervice, &c. which was declared to be contrary to the laws and ftatutes of this realm, the *petition of right* and liberty of the fubject, by ftat. 17 Car. I. c. 14. See *Blackftone's Commentaries*, vol. iv. p. 30.

SHIP-Shape, according to the fafhion of a fhip, or in the manner of an expert failor; as, The maft is not rigged fhip-fhape; Trim your fails fhip-fhape.

Stowing and Trimming of SHIPS, the method of difpofing of the cargo in a proper and judicious manner in the hold of a fhip.

A fhip's failing, fteering, ftaying, and wearing, and being lively and comparatively eafy at fea in a ftorm, depends greatly on the cargo, ballaft, or other materials, being properly ftowed, according to their weight and bulk, and the proportional dimenfions of the built of the fhip, which may be made too crank or too ftiff to pafs on the ocean with fafety. Thefe things render this branch of knowledge of fuch confequence, that rules for it ought to be endeavoured after, if but to prevent, as much as poffible, the danger of a fhip overfetting at fea, or being fo labourfome as to roll away her mafts, &c. by being improperly ftowed, which is often the cafe.

When a fhip is new, it is prudent to confult the builder, who may be fuppofed beft acquainted with a fhip of his own planning, and moft likely to judge what her properties will be, to advife how the cargo or materials, according to the nature of them, ought to be difpofed of to advantage, fo as to put her in the beft failing trim; and at every favourable opportunity afterwards it will be proper to endeavour to find out her beft trim by experiment.

Ships muft differ in their form and proportional dimenfions; and to make them anfwer their different purpofes, they will require different management in the ftowage, which ought not to be left to mere chance, or done at random, as goods or materials happen to come to hand, which is too often the caufe that fuch improper ftowage makes fhips unfit for fea: therefore the ftowage fhould be confidered, planned, and contrived, according to the built and properties of the fhip, which if they are not known fhould be inquired after. If fhe is narrow and high-built in proportion, fo that fhe will not fhift herfelf without a great weight in the hold, it is a certain fign fuch a fhip will require a great part of heavy goods, ballaft, or materials, laid low in the hold, to make her ftiff enough to bear fufficient fail without being in danger of overfetting. But if a fhip be built broad and low in proportion, fo that fhe is ftiff and will fupport herfelf without any weight in the hold, fuch a fhip will require heavy goods, ballaft, or materials, ftowed higher up, to prevent her from being too ftiff and labourfome at fea, fo as to endanger her mafts being roiled away, and the hull worked loofe and made leaky.

Ship.

In order to help a fhip's failing, that fhe fhould be lively and eafy in her pitching and afcending motions, it fhould be contrived by the ftowage, that the principal and weightieft part of the cargo or materials fhould lie as near the main body of the fhip, and as far from the extreme ends, fore and aft, as things will admit of. For it fhould be confidered, that the roomy part of our fhips lengthwife forms a fweep or curve near four times as long as they are broad; therefore thofe roomy parts at and above the water's edge, which are made by a full harping and a broad tranfom to fupport the fhip fteady and keep her from plunging into the fea, and alfo by the entrance and run of the fhip having little or no bearing body under for the preffure of the water to fupport them, of courfe fhould not be ftowed with heavy goods or materials, but all the neceffary vacancies, broken ftowage, or light goods, fhould be at thefe extreme ends fore and aft; and in proportion as they are kept lighter by the ftowage, the fhip will be more lively to fall and rife eafy in great feas; and this will contribute greatly to her working and failing, and to prevent her from ftraining and hogging; for which reafon it is a wrong practice to leave fuch a large vacancy in the main hatchway, as is ufual, to coil and work the cables, which ought to be in the fore or after hatchway, that the principal weight may be more eafily ftowed in the main body of the fhip, above the flatteft and loweft floorings, where the preffure of the water acts the more to fupport it.

Improved Capftan of SHIPS.—A capftan has been contrived by Mr Bofwell, which works without requiring the meffenger or cable coiled around it, to be ever furged; an operation which is neceffary with common capftans, and is always attended with delay, and frequently with danger. This capftan has been approved by fome gentlemen connected with the Britifh navy. A model of this machine was prefented to the Society for the Encouragement of Arts, and Mr Bofwell received the gold medal of the fociety for his invention *.

* *Tranf.* for 1807. *Phil. Mag.* xxxi. 267.

For the information of thofe unacquainted with maritime affairs, Mr Bofwell gives an account of the manner in which cables are hauled on board of large fhips. For the purpofe of fhewing the advantage of his improved capftan, cables, he obferves, above a certain diameter are too inflexible to admit of being coiled round a capftan; in fhips where cables of fuch large dimenfions are neceffary, a fmaller cable is employed for this purpofe, which is called the *meffenger*, the two ends of which are made faft together fo as to form an endlefs rope, which, as the capftan is turned about, rolls round it in unceafing fucceffion, paffing on its courfe to the head of the fhip, and again returning to the capftan. To this returning part of the meffenger, the great cable is made faft by a number of fmall ropes called nippers, placed at regular intervals; thefe nippers are applied, as the cable enters the hawfe hole, and are again removed as it approaches the capftan, after which it is lowered into the cable tier.

The meffenger, or any other rope coiled round the capftan, muft defcend a fpace at every revolution equal to the diameter of the rope or cable ufed; this circum-ftance ſtance brings the coils in a few turns to the bottom of the capſtan, when it can no longer be turned round, till the coils are looſened and raiſed up to its other extremity, after which the motion proceeds as before. This operation of ſhifting the place of the coils of the meſſenger on the capſtan is called *ſurging the meſſenger*. It always cauſes conſiderable delay; and when the meſſenger chances to ſlip in changing its poſition, which ſometimes happens, no ſmall danger is incurred by thoſe who are employed about the capſtan.

One method of preventing the neceſſity of ſurging, by placing a horizontal roller beneath the meſſenger when it firſt enters on the capſtan, adds conſiderably to the labour in turning the capſtan, and the great friction which the meſſenger muſt ſuffer, muſt occaſion a very great wear and injury to the meſſenger.

Another method to prevent ſurging was, that for which Mr Plucknet obtained a patent. In this way a number of upright lifters, placed round the capſtan, were made to riſe in ſucceſſion as the capſtan turned round by a circular inclined plane placed beneath them; a method Mr Boſwell thinks ſuperior to the former; but ſtill the wear of the meſſenger from the lateral friction in riſing againſt the whelps of the capſtan remains undiminiſhed.

A third method propoſed by Captain Hamilton, left the lateral friction, and wear of the meſſenger againſt the whelps of the capſtan, as great as in the others, having alſo the inconvenience of cauſing the coils to become looſe as they aſcend, the upper part of the barrel being nearly one third leſs in the diameter than the lower part.

In Mr Boſwell's method of preventing the neceſſity of ſurging, none of the lateral friction of the meſſenger or cable againſt the whelps of the capſtan, can poſſibly take place, and of courſe the wear of the meſſenger occaſioned thereby will be entirely avoided, while it performs its purpoſe with a leſs moving power than any of them.

His method conſiſts in the ſimple addition of a ſecond ſmaller barrel or capſtan of leſs dimenſions to the large one; beſide which it is to be placed in a ſimilar manner, and which need not in general exceed the ſize of a half barrel caſk. The coils of the meſſenger are to be paſſed alternately round the large capſtan and this ſmall barrel, but with their direction reverſed in the different barrels, ſo that they may croſs each other in the intervals between the barrels, in order to have the more extenſive contact with, and better gripe on each barrel. To keep the coils diſtinct, and prevent their touching each other in paſſing from one barrel to the other, projecting rings are faſtened round each barrel at a diſtance from each other equal to about two diameters of the meſſenger, and the thickneſs of the ring. Thoſe rings ſhould be ſo fixed on the two barrels that thoſe on one barrel ſhould be exactly oppoſite the middle of the intervals between thoſe on the other barrel; the only circumſtance which requires particular attention in the conſtruction of this capſtan. The rings ſhould project about as much as the meſſenger from the barrels, which may be formed with whelps, and in every other reſpect, not before mentioned, in the uſual manner for capſtan barrels. The ſmall barrel ſhould be furniſhed with falling palls as well as the large one; a fixed iron ſpindle aſcending from the deck will be the beſt for it, as it will take up leſs room. The ſpindle may be ſecured below the deck, ſo as to bear any ſtrain, as the ſmall barrel need not be much above half the height of the large barrel; the capſtan bars can eaſily paſs over it in heaving round, when it is thought fit to uſe capſtan bars on the ſame deck with the ſmall barrel. As two turns of the meſſenger round both barrels will be at leaſt equivalent to three turns round the common capſtan, it will ſcarcely ever be neceſſary to uſe more than four turns round the two barrels.

That which prevents the lateral friction of the meſſenger in Mr Boſwell's double capſtan is, that in it each coil is kept diſtinct from the reſt, and muſt paſs on to the ſecond barrel before it can gain the next elevation on the firſt, by which no one coil can have any influence in raiſing or depreſſing another; and what each ſeparate coil deſcends in a ſingle revolution it regains as much as is neceſſary in its paſſage between the barrels when in the air, and free from all contact with any part of the apparatus, it attains a higher elevation without a poſſibility of friction or wear.

It is equally applicable in large and in ſmaller veſſels, in the former of which meſſengers are neceſſary, from the ſize of the cables; but in the latter alſo, where cables can be managed with the ſame eaſe as meſſengers. The ſame principle may be alſo eaſily applied to windlaſſes by having a ſmall horizontal barrel placed parallel to the body of the windlaſs, and having both fitted with rings in the ſame way as is propoſed for the capſtan. The place for the ſmall horizontal barrel is forward, juſt before the windlaſs, and it ſhould alſo be furniſhed with catch polls.

Beſides the advantages now ſtated, the improved capſtan is ſimple in its conſtruction can be fitted up at ſmall expence, is eaſily repaired, and requires but little room.

A repreſents the common capſtan; B, another of ſmaller dimenſions; C the coils of the meſſenger paſſing alternately round the large and ſmall capſtans, but with the dieection reverſed on the different barrels, ſo that they may croſs each other in the interval between them; DDDD, are projecting rings round each barrel, ſo fixed on the two barrels, that thoſe on one barrel ſhould be exactly oppoſite the middle of the intervals between thoſe on the other barrel. Plate cccexciv.

Machine for meaſuring a SHIP's Way.—We have already deſcribed a variety of machines or inſtruments which have been propoſed for this purpoſe under the article LOG. In this place, therefore, we ſhall confine ourſelves to the machine invented by Francis Hopkinſon, Eſq. Judge of the Admiralty in Pennſylvania.— After having ſhown the fallacies to which the common log, and alſo that particular kind of inſtrument invented by M. Saumarez, are liable, he proceeds to deſcribe his own machine as follows: *Tranſactions of the American Philoſophical Society*, vol. ii. p. 160.

This machine, in its moſt ſimple form, is repreſented by fig. 5. wherein AB is a ſtrong rod of iron moveable on the fulcrum C. D is a thin circular palate of braſs rivetted to the lower extremity of the rod. E a horizontal arm connected at one end with the top of the rod AB by a moveable joint F, and at the other end with the bottom of the index H, by a like moveable joint G. H is the index turning on its centre I, and travelling over the graduated arch K; and L is a ſtrong ſpring, bearing againſt the rod AB, and conſtantly counteracting the preſſure upon the palate D. Plate cccclxxxiii. Fig. 5.

The

Ship. The rod AB should be applied close to the cut-water or stem, and should be of such a length that the palate D may be no higher above the keel than is necessary to secure it from injury when the vessel is aground, or sails in shoal water. As the bow of the ship curves inward towards the keel M, the palate D will be thrown to a distance from the bottom of the vessel, although the perpendicular rod to which it is annexed lies close to the bow above; and therefore the palate will be more fairly acted upon. The arm E should enter the bow somewhere near the hawse hole, and lead to any convenient place in the forecastle, where a smooth board or plate may be fixed, having the index H, and graduated arch K, upon it.

It is evident from the figure, that as the ship is urged forward by the wind, the palate D will be pressed upon by the resisting medium, with a greater or less force, according to the progressive motion of the ship; and this will operate upon the levers so as to immediately affect the index, making the least increase or diminution of the ship's way visible on the graduated arch; the spring L always counteracting the pressure upon the palate, and bringing back the index, on any relaxation of the force impressed.

This machine is advantageously placed at the bow of the ship, where the current first begins, and acts fairly upon the palate, in preference to the stern, where the tumultuous closing of the water causes a wake, visible to a great distance. The palate D is sunk nearly as low as the keel, that it may not be influenced by the heaping up of the water and the dashing of the waves at and near the water line. The arch K is to ascertain how many knots or miles she would run in one hour at her then rate of sailing. But the graduations on this arch must be unequal; because the resistance of the spring L will increase as it becomes more bent, so that the index will travel over a greater space from one to five miles than from five to twelve. Lastly, The palate, rod, spring, and all the metallic parts of the instrument, should be covered with a strong varnish, to prevent rust from the corrosive quality of the salt water and sea air.

This machine may be considerably improved as follows: Let the rod or spear AB (fig. 5.) be a round rod of iron or steel, and instead of moving on the fulcrum or joint, as at C, let it pass through and turn freely in a socket, to which socket the moveable joint must be annexed, as represented in fig. 6. The rod must have a shoulder to bear on the upper edge of the socket, to prevent its slipping quite down. The rod must also pass through a like socket at F, fig. 5. The joint of the lower socket must be fixed to the bow of the ship, and the upper joint or socket must be connected with the horizontal arm E. On the top of the uppermost socket let there be a small circular plate, bearing the 32 points of the mariner's compass; and let the top of the rod AB come through the centre of this plate, so as to carry a small index upon it, as is represented in fig. 7. This small index must be fixed to the top of the rod on a square, so that by turning the index round the plate, the rod may also turn in the sockets, and of course carry the palate D round with it; the little index always pointing in a direction with the face of the palate. The small compass plate should not be fastened to the top of the socket, but only fitted tightly on, that it may be moveable at pleasure. Suppose then the intended port to bear S. W. from the place of departure, the palate must be turned on the socket till the south-west point thereon looks directly to the ship's bow; so that the south-west and north-east line on the compass plate may be precisely parallel with the ship's keel, and in this position the plate must remain during the whole voyage. Suppose, then, the ship to be sailing in the direct course of her intended voyage, with her bowsprit pointing south-west. Let the little index be brought to the south-west point on the compass plate, and the palate D will necessarily present its broad face toward the port of destination; and this it must always be made to do, be the ship's course what it may. If, on account of unfavourable winds, the ship is obliged to deviate from her intended course, the little index must be moved so many points from the south-west line of the compass plate as the compass in the binnacle shall show that she deviates from her true course; so that in whatever direction the ship shall sail, the palate D will always look full to the south-west point of the horizon, or towards the port of destination, and consequently will present only an oblique surface to the resisting medium, more or less oblique as the ship deviates more or less from the true course of her voyage. As, therefore, the resistance of the water will operate less upon the palate in an oblique than in a direct position, in exact proportion to its obliquity, the index H will not show how many knots the vessel runs in her then course, but will indicate how many she gains in the direct line of her intended voyage.—Thus, in fig. 9. if the ship's course lies in the direction of the line AB, but she can sail by the wind no nearer than AC; suppose, then, her progressive-motion such as to perform AC equal to five knots or miles in an hour, yet the index H will only point to four knots on the graduated arch, because she gains no more than at that rate on the true line of her voyage, viz. from A to B. Thus will the difference between her real motion and that pointed out by the index be always in proportion to her deviation from her intended port, until she sails in a line at right angles therewith, as AD; in which case the palate would present only a thin sharp edge to the resisting medium, the pressure of which should not be sufficient to overcome the friction of the machine and the bearing of the spring L. So that at whatever rate the ship may sail on that line, yet the index will not be affected, showing that she gains nothing on her true course. In this case, and also when the vessel is not under way, the action of the spring L should cause the index to point at O, as represented by the dotted lines in fig. 5. and 8.

As the truth of this instrument must depend on the equal pressure of the resisting medium upon the palate D, according to the ship's velocity, and the proportionable action of the spring L, there should be a pin or screw at the joints C and F, so that the rod may be readily unshipped and taken in, in order to clean the palate from any foulness it may contract, which would greatly increase its operation on the index H, and thereby render the graduated arch false and uncertain.

Further, the spring L may be exposed too much to injury from the salt water, if fixed on the outside of the ship's bow. To remedy this, it may be brought under cover, by constructing the machine as represented by fig. 8. where AB is the rod, C the fulcrum or centre of of its motion, D the palate, E the horizontal arm leading through a ſmall hole into the forecaſtle; M is a ſtrong chain faſtened at one end to the arm E, and at the other to a rim or barrel on the wheel G, which by means of its teeth gives motion to the ſemicircle I and index H. The ſpring L is ſpiral, and encloſed in a box or barrel, like the main-ſpring of a watch. A ſmall chain is fixed to, and paſſing round the barrel, is faſtened by the other end to the fuzee W. This fuzee is connected by its teeth with the wheel G, and counteracts the motion of the palate D. N, N, are the two ſockets through which the rod AB paſſes, and in which it is turned round by means of the little index R. S is the ſmall compaſs plate, moveable on the top of the upper ſocket N. The plate S hath an upright rim round its edge, cut into teeth or notches, ſo that when the index R is a little raiſed up, in order to bring it round to any intended point, it may fall into one of theſe notches, and be detained there; otherwiſe the preſſure of the water will force the palate D from its oblique poſition, and turn the rod and index round to the direction in which the ſhip ſhall be then ſailing.—Should it be apprehended that the palate D, being placed ſo far forward, may affect the ſhip's ſteerage, or obſtruct her rate of ſailing, it ſhould be conſidered that a very ſmall plate will be ſufficient to work the machine, as one of three or four inches in diameter would probably be ſufficient, and yet not large enough to have any ſenſible effect on the helm or ſhip's way.

The greateſt difficulty, perhaps, will be in graduating the arch K, (if the machine is conſtructed as in fig. 5.); the unequal diviſions of which can only be aſcertained by actual experiment on board of each ſhip reſpectively, inaſmuch as the accuracy of theſe graduations will depend on three circumſtances, viz. the poſition of the fulcrum C with reſpect to the length of the rod, the ſize of the palate D, and the ſtrength or bearing of the ſpring L. When theſe graduations, however, are once aſcertained for the machine on board of any one veſſel, they will not want any future alterations, provided the palate D be kept clean, and the ſpring L retains its elaſticity.

But the unequal diviſions of the graduated arch will be unneceſſary, if the machine is conſtructed as in fig. 8; for as the chain goes round the barrel L, and then winds through the ſpiral channel of the fuzee W, the force of the main ſpring muſt operate equally, or nearly ſo, in all poſitions of the index, and conſequently the diviſions of the arch K may in ſuch caſe be equal.

After all, it is not expected that a ſhip's longitude can be determined to a mathematical certainty by this inſtrument. The irregular motions and impulſes to which a ſhip is continually expoſed, make ſuch an accuracy unattainable perhaps by any machinery: But if it ſhould be found, as we flatter ourſelves it will on fair experiment, that it anſwers the purpoſe much better than the common log, it may be conſidered as an acquiſition to the art of navigation.

It ſhould be obſerved, that in aſcertaining a ſhip's longitude by a time-piece, this great inconvenience occurs, that a ſmall and trifling miſtake in the time makes a very great and dangerous error in the diſtance run: Whereas the errors of this machine will operate no farther than their real amount; which can never be great or dangerous, if corrected by the uſual obſervations made by mariners for correcting the common log.

A like machine, made in its ſimple form (as at fig. 5.), ſo conſtructed as to ſhip and unſhip, might occaſionally be applied alongſide about midſhips, in order to aſcertain the leeway; which, if rightly ſhown, will give the ſhip's preciſe longitude. As to ſea currents, this and all other machines hitherto invented muſt be ſubject to their influence; and proper allowances muſt be made according to the ſkill and knowledge of the navigator.

Laſtly, Some diſcretion will be neceſſary in taking obſervations from the machine to be entered on the log-book: that is, the moſt favourable and equitable moment ſhould be choſen for the obſervation; not whilſt the ſhip is rapidly deſcending the declivity of a wave, or is ſuddenly checked by a ſtroke of the ſea, or is in the very act of plunging. In all caſes, periods may be found in which a ſhip proceeds with a true average velocity; to diſcover which, a little experience and attention will lead the ſkilful mariner.

It has been obſerved of the machine now deſcribed, that an ingenious mechanic would probably conſtruct it to better advantage in many reſpects. The author only meant to ſuggeſt the principle; experiment alone can point out the beſt method of applying it. He is ſenſible of at leaſt one deficiency, viz. that the little index R, fig. 4. will not be ſtrong enough to retain the palate D in an oblique poſition when the ſhip is ſailing by the wind; more eſpecially as the compaſs plate S, in whoſe notched rim the index R is to fall, is not fixed to, but only fitted tight on the ſocket N. Many means, however, might be contrived to remedy this inconvenience.

SHIP-Wreck. A French author has lately propoſed ſome methods of ſaving the lives of perſons ſhipwrecked near the coaſt. He obſerves, that the moſt proper means for ſaving the crews of ſhipwrecked veſſels is, to eſtabliſh a rope of communication from them to the ſhore. To a bomb or cannon ball ſhould be faſtened the end of a rope, extended afterwards in a zig-zag direction before the mortar or cannon, or ſuſpended on a piece of wood raiſed ſeveral feet. But as it was neceſſary to know if the cord would not break by the force of the exploſion and the velocity of the motion, the author thought it proper to conſult profeſſional men. He accordingly wrote to ſome officers of the artillery in garriſon at La Fere in France, and they almoſt all replied that the rope would infallibly break.

Not deeming this anſwer ſatisfactory, he happily conceived the idea of making the experiment on a ſmall ſcale. He cauſed a piece of the barrel of a muſket to be filed into the form of a ſmall mortar of 18 lines in length internally; and having tied a packthread to a common ball of lead, he made an experiment which perfectly ſucceeded, as did many others which he afterwards repeated, even with the ſtrongeſt charges of powder. This ſucceſs he communicated to the officers of artillery, who replied, that there was a great difference between a quarter of an ounce of powder and four or five pounds employed for a bomb; and were ſtill of opinion that the rope would break.

Having already made experiments, he was ſtill diſpoſed to doubt the truth of this aſſertion, and therefore tried a four-inch mortar with a ball of the ſame calibre, and 18 ounces of powder, with a rope only three or four

four lines in diameter, and his fuccefs was equally flattering as before. Thefe experiments were repeated by order of government at La Fere, four times with an eight-inch mortar, and three times with one of twelve inches, all of which happily fucceeded. The fame author goes on to obferve;

"It ought to be remembered, that a veffel is never caft away, or perifhes on the coaft, but becaufe it is driven thither againft the will of the captain, and by the violence of the waves and the wind, which almoft always blows from the fea towards the fhore, without which there would be no danger to be apprehended: confequently in thefe circumftances, the wind comes always from the fea, either directly or obliquely, and blows towards the fhore.

"1ft, A common paper kite, therefore, launched from the veffel and driven by the wind to the fhore, would be fufficient to fave a crew of 1500 feamen, if fuch were the number of a fhip of war. This kite would convey to the fhore a ftrong packthread, to the end of which might be affixed a cord, to be drawn on board by means of the ftring of the kite; and with this cord a rope, or as many as fhould be neceffary, might be conveyed to the fhip.

"2d, A fmall balloon, of fix or feven feet in diameter, and raifed by rarefied air, would be alfo an excellent means for the like purpofe. Being driven by the wind from the veffel to the fhore, it would carry thither a ftring capable of drawing a cord with which feveral ropes might be afterwards conveyed to the veffel. Had not the difcovery of Montgolfier produced any other benefit, it would be entitled on this account to be confidered as of great importance.

"3dly, A fky rocket, of a large diameter, would be of equal fervice. It would alfo carry, from the veffel to the fhore, a ftring capable of drawing a rope after it.

"Laftly, A fourth plan for faving the crew of a fhipwrecked veffel, is that of throwing from the veffel into the fea an empty cafk with a cord attached to it. The wind and the waves would drive the cafk to the fhore, and afford the means of eftablifhing that rope of communication already mentioned."

The author juft quoted fays, that he announced his difcovery in a French journal in January 1794. It is, however, to be obferved, that the method he propofes of conveying a rope to the fhore, by faftening it to a bullet or bomb, to be afterwards fired from a cannon or mortar, was propofed fome years ago by a ferjeant or officer of artillery at Woolwich, and it is faid, fimilar experiments were made at Portfmouth, and fucceeded *.

* Phil. Mag. vol. iv. p. 247.

SHIRAUZ. See SCHIRAS.

SHIRE, is a Saxon word fignifying a divifion; but a county, *comitatus*, of the fame import, is plainly derived from *comes*, "the count of the Franks;" that is, the earl or alderman (as the Saxons called him) of the fhire, to whom the government of it was entrufted. This he ufually exercifed by his deputy, ftill called in Latin *vice-comes*, and in Englifh the *fheriff*, *fhrieve*, or *fhire-reeve*, fignifying the "officer of the fhire;" upon whom, in procefs of time, the civil adminiftration of it totally devolved. In fome counties there is an intermediate divifion between the fhire and the hundred; as lathes in Kent and rapes in Suffex, each of them containing about three or four hundred a-piece. Thefe had formerly their lathe-reeves and rape-reeves, acting in fubordination to the fhire-reeve. Where a county is divided into three of thefe intermediate jurifdictions, they are called *trithings*, which were anciently governed by a trithing reeve. Thefe trithings ftill fubfift in the large county of York, where, by an eafy corruption, they are denominated *ridings*; the north, the eaft, and the weft ridings.

SHIRL, SHORL, or COCKLE, a fpecies of mineral. See MINERALOGY *Index*.

SHIRT, a loofe garment, commonly of linen, worn next the body.—Some doubt the propriety of changing the linen when a perfon is fick. Clean linen promotes perfpiration; and it may be renewed as often as the patient pleafes, whether the diforder be of the acute or the chronical kind. Except during a crifis in fevers, whilft the patient is in a fweat, a change of linen, if well dried and warmed, may be daily ufed.

Shirts were not worn by the Jews, Greeks, or Romans, but their place was fupplied by thin *tunicæ* of wool. The want of linen among the ancients made frequent wafhings and ablutions neceffary.

SHIVER, a name given by miners to fome of the ftrata which accompany coal. See SCHISTUS, MINERALOGY *Index*.

SHIVERS, in the fea language, names given to the little rollers, or round wheels of pulleys.

SHOAD, among miners, denotes a train of metalline ftones, ferving to direct them in the difcovery of mines.

SHOAD-Stones, a term ufed by the miners of Cornwall and other parts of this kingdom, to exprefs fuch loofe maffes of ftone as are ufually found about the entrances into mines, fometimes running in a ftraight courfe from the load or vein of ore to the furface of the earth.

Thefe are ftones of the common kinds, appearing to have been pieces broken from the ftrata or larger maffes; but they ufually contain mundic, or marcafitic matter, and more or lefs of the ore to be found in the mine. They appear to have been at fome time rolled about in water, their corners being broken off, and their furface fmoothed and rounded.

The antimony mines in Cornwall are always eafily difcovered by the fhoad-ftones, thefe ufually lying up to the furface, or very nearly fo; and the matter of the ftone being a white fpar, or debafed cryftal, in which the native colour of the ore, which is a fhining bluifh black, eafily difcovers itfelf in ftreaks and threads.

Shoad-ftones are of fo many kinds, and of fuch various appearances, that it is not eafy to defcribe or know them; but the miners, to whom they are of the greateft ufe in the tracing or fearching after new mines, diftinguifh them from other ftones by their weight; for if very ponderous, though they look ever fo much like common ftones, there is great reafon to fufpect that they contain fome metal. Another mark of them is their being fpongy and porous; this is a fign of efpecial ufe in the tin countries; for the tin fhoad-ftones are often fo porous and fpongy, that they refemble large bodies thoroughly calcined. There are many other appearances of tin fhoads, the very hardeft and firmeft ftones often containing this metal.

When the miners, in tracing a fhoad up hill, meet with fuch odd ftones and earths that they know not well what to make of them, they have recourfe to vanning, that is, they calcine and powder the ftone, clay, or whatever elfe is fuppofed to contain the metal; and then

then wafhing it in an inftrument, prepared for that purpofe, and called a *vanning fhovel*, they find the earthy matter wafhed away, and of the remainder, the ftony or gravelly matter lies behind, and the metalline matter at the point of the fhovel. If the perfon who performs this operation has any judgement, he eafily difcovers not only what the metal is that is contained in the fhoad, but alfo will make a very probable guefs at what quantity the mine is likely to yield of it in proportion to the ore.

SHOAL, in the fea language, denotes a place where the water is fhallow; and likewife a great quantity of fifhes, fuch as a *fhoal of herrings*.

SHOCK, in *Electricity*. The effect of the explofion of a charged body, that is, the difcharge of its electricity on any other body, is called the *electric fhock*.

SHOE, a covering for the foot, ufually of leather.

SHOES, among the Jews, were made of leather, linen, rufh, or wood; thofe of foldiers were fometimes of brafs or iron. They were tied with thongs which paffed under the foles of the feet. To put off their fhoes was an act of veneration; it was alfo a fign of mourning and humiliation: to bear one's fhoes, or to untie the latchets of them, was confidered as the meaneft fervice.

Among the Greeks fhoes of various kinds were ufed. Sandals were worn by women of diftinction. The Lacedemonians wore red fhoes. The Grecian fhoes generally reached to the middle of the leg. The Romans ufed two kinds of fhoes; the *calceus*, which covered the whole foot fomewhat like our fhoes, and was tied above with latchets or ftrings; and the *folea* or flipper, which covered only the fole of the foot, and was faftened with leathern thongs. The calceus was always worn along with the *toga* when a perfon went abroad: flippers were put on during a journey and at feafts, but it was reckoned effeminate to appear in public with them. Black fhoes were worn by the citizens of ordinary rank, and white ones by the women. Red fhoes were fometimes worn by the ladies, and purple ones by the coxcombs of the other fex. Red fhoes were put on by the chief magiftrates of Rome on days of ceremony and triumphs. The fhoes of fenators, patricians, and their children, had a crefcent upon them which ferved for a buckle; thefe were called *calcei lunati*. Slaves wore no fhoes; hence they were called *cretati* from their dufty feet. Phocion alfo and Cato Uticenfis went without fhoes. The toes of the Roman fhoes were turned up in the point; hence they were called *calcei roftrati, repandi*, &c.

In the 9th and 10th centuries the greateft princes of Europe wore wooden fhoes, or the upper part of leather and the fole of wood. In the reign of William Rufus, a great beau, Robert, furnamed *the horned*, ufed fhoes with long fharp points, ftuffed with tow, and twifted like a ram's horn. It is faid the clergy, being highly offended, declaimed againft the long-pointed fhoes with great vehemence. The points, however, continued to increafe till, in the reign of Richard II. they were of fo enormous a length that they were tied to the knees with chains, fometimes of gold, fometimes of filver. The upper parts of thefe fhoes in Chaucer's time were cut in imitation of a church window. The long-pointed fhoes were called *crackowes*, and continued in fafhion for three centuries in fpite of the bulls of popes, the decrees of councils, and the declamations of the clergy. At length the parliament of England interpofed by an act A. D. 1463, prohibiting the ufe of fhoes or boots with pikes exceeding two inches in length, and prohibiting all fhoemakers from making fhoes or boots with longer pikes under fevere penalties. But even this was not fufficient: it was neceffary to denounce the dreadful fentence of excommunication againft all who wore fhoes or boots with points longer than two inches. The prefent fafhion of fhoes was introduced in 1633, but the buckle was not ufed till 1670.

In Norway they ufe fhoes of a particular conftruction, confifting of two pieces, and without heels; in which the upper leather fits clofe to the foot, the fole being joined to it by many plaits or folds.

The fhoes or flippers of the Japanefe, as we are informed by Profeffor Thunberg, are made of rice-ftraw woven, but fometimes for people of diftinction of fine flips of ratan. The fhoe confifts of a fole, without upper leather or hind-piece; forwards it is croffed by a ftrap, of the thicknefs of one's finger, which is lined with linen; from the tip of the fhoe to the ftrap a cylindrical ftring is carried, which paffes between the great and fecond toe, and keeps the fhoe faft on the foot. As thefe fhoes have no hind-piece, they make a noife when people walk in them like flippers. When the Japanefe travel, their fhoes are furnifhed with three ftrings made of twifted ftraw, with which they are tied to the legs and feet, to prevent them from falling off. Some people carry one or more pairs of fhoes with them on their journeys, in order to put on new, when the old ones are worn out. When it rains, or the roads are very dirty, thefe fhoes are foon wetted through, and one continually fees a great number of worn-out fhoes lying on the roads, efpecially near the brooks, where travellers have changed their fhoes after wafhing their feet. Inftead of thefe, in rainy or dirty weather they wear high wooden clogs, which underneath are hollowed out in the middle, and at top have a band acrofs like a ftirrup, and a ftring for the great toe; fo that they can walk without foiling their feet. Some of them have their ftraw fhoes faftened to thefe wooden clogs. The Japanefe never enter their houfes with their fhoes on; but leave them in the entry, or place them on the bench near the door, and thus are always barefooted in their houfes, fo as not to dirty their neat mats. During the time that the Dutch live at Japan, when they are fometimes under an obligation of paying vifits at the houfes of the Japanefe, their own rooms at the factory being likewife covered with mats of this kind, they wear, inftead of the ufual fhoes, red, green, or black flippers, which, on entering the houfe they pull off: however, they have ftockings on, and fhoes made of cotton ftuff with buckles in them, which fhoes are made at Japan, and can be wafhed whenever they are dirty. Some have them of black fatin, in order to avoid wafhing them.

SHOE of an Anchor, a fmall block of wood, convex on the back, and having a fmall hole, fufficient to contain the point of the anchor fluke, on the forefide. It is ufed to prevent the anchor from tearing or wounding the planks on the fhip's bow, when afcending or defcending; for which purpofe the fhoe flides up and down along the bow between the fluke of the anchor and the planks, as being preffed clofe to the latter by the weight of the former.

To SHOE an Anchor, is to cover the flukes with a broad

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broad triangular piece of plank, whose area or superficies is much larger than that of the flukes. It is intended to give the anchor a stronger and surer hold of the bottom in very soft and oozy ground.

SHOEMAKERS MACHINE for working at in a standing posture. A machine for this purpose was invented by Mr Thomas Parker, who, on the 22d of November, 1804, attended a committee appointed by the Society of Arts, and informed them that he had made use of this apparatus for twelve months, and found it very useful. He observed that all the work of shoe-making may be done with it standing; but that in some parts thereof he found an advantage in using along with it a high stool; and that prior to the use of this machine, he never saw or heard of a similar invention; and that he found it of great service to his health.

He estimated the cost of such a machine at two guineas.

Plate CCCCXCVI. Fig. 1.

Plate CCCCXCVI. fig. 1. T, a bench standing on four legs, about four feet from the ground.

V, A circular cushion affixed to the bench, in the centre of which cushion is an open space quite through the bench, through which hole a leather strap U is brought up from below. This strap holds the work and last firm upon the cushion in any position required, by means of the workman's foot placed upon the treadle W.

X, Shews the last upon the cushion, with the strap holding it firm.

Y, An implement used in closing boots.

Z, A small flat leather cushion, useful in adjusting the last and strap.

L, The shoe-last shewn separate from the cushion. The round cushion is formed of a circular piece of wood, covered with leather or stuffed with wool or hair to give it some elasticity.

Another machine for the same purpose has been invented by Mr Holden of Fettleworth in Suffex, and the following account of it was presented to the Society of Arts. He observes that the sitting posture had so greatly injured his health, as to render it necessary to give up his business, and in this difficulty he invented the machine which he found to answer the purpose fully, as it enabled him to resume his work with the recovery of his health. He recommends it as the quickest way of closing all the thread work, and he adds, that he has made 1800 or 2000 pairs of shoes with the machine, and still continues to employ it. The following is a description of the machine.

Fig. 2.

Fig. 2. A, The bed for the closing block, and to lay the shoe in, whilst sewing.

B, The closing block.

C, A loose bed to lay the shoe in whilst stitching; the lower part of which is here exhibited reversed, to shew how it is placed in the other bed A.

D, The hollow or upper part of the loose bed C, in which the shoe is laid while stitching.

E, A table on which the tools wanted are to be laid.

F, An iron semi-circle, fixed to each end of the bed A, to allow the bed to be raised or depressed. This half circle moves in the block G.

H, Another iron semi-circle, with notches, which catch upon a tooth in the centre of the block, to hold the bed in any angle required. This semi-circle moves sidewise on two hooks in staples at each end of the bed.

I, The tail or stem of the bed A, moving in a cylindrical hole in the pillar, enabling the bed to be turned in any required direction, and which, with the movement F, enables the operator to place the shoe in any position necessary.

Shoemakers || Shooting.

K, The pillar, formed like the pillar of a clawtable, excepting the two side legs being in a direct line, and the other leg at a right angle with them.

L, The semi-circle H, shewn separately, to explain how it is connected with the staples, and how the notches are formed.

M, The tail or stem of the bed A, and the lower part of the bed N, shewn separately, to explain how the upper part of the bed is raised or depressed occasionally.

Horse-SHOE. See FARRIERY, N° 131.

SHOOTING, in the military art. See ARTILLERY, GUNNERY, and PROJECTILES.

1 Shooting in sportmanship.

SHOOTING, in sportmanship, the killing of game by the gun, with or without the help of dogs.

Under this article we shall lay down all the rules which are necessary to be observed in order to render one accomplished and successful in the art of shooting.

2 Directions for choosing a fowling-piece.

The first thing which the sportsman ought to attend to is the choice of his fowling-piece. Conveniency requires that the barrel be as light as possible, at the same time it ought to possess that degree of strength which will make it not liable to burst. Experience has proved, that a thin and light barrel, which is of equal thickness in every part of its circumference, is much less liable to burst than one which is considerably thicker and heavier, but which, from being badly filed or bored, is of unequal strength in different places.

It is also of importance to determine of what length the barrel ought to be, in order to acquire that range which the sportsman has occasion for. On this subject we have received the following information from an experienced sportsman. We have, at different times, compared barrels of all the intermediate lengths between 28 and 40 inches, and of nearly the same caliber, that is to say, from 22 to 26; and these trials were made both by firing the pieces from the shoulder, and from a firm block, at an equal distance, and with equal weights of the same powder and of the same shot.

To avoid every possibility of error, the quires of paper at which we fired were fixed against planks instead of being placed against the wall. From these trials frequently repeated, we found that the shot pierced an equal number of sheets, whether it was fired from a barrel of 28, 30, 32, 34, 36, 38, or 40, inches in length. Nay more, we have compared two barrels of the same caliber, but one of them 33, and the other 66 inches long, by repeatedly firing them in the same manner as the others, at different distances, from 45 to 100 paces, and the results have always been the same, i. e. the barrel of 33 inches drove its shot through as many sheets of paper as that of 66 did. The conclusion from all this is, that the difference of 10 inches in the length of the barrel, which seems to be more than is ever insisted upon among sportsmen, produces no sensible difference in the range of the piece; and therefore, that every one may please himself in the length of his barrel, without either detriment or advantage to the range.

It may appear as an objection to this, that a duck-gun which is five or six feet long kills at a greater distance than

Shoemakers MACHINE.

Plate CCCCXCVI.

Fig. 1.

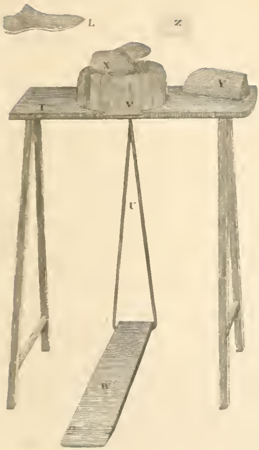
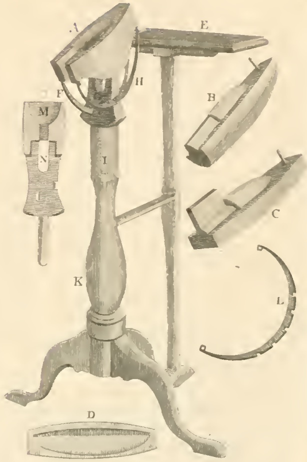
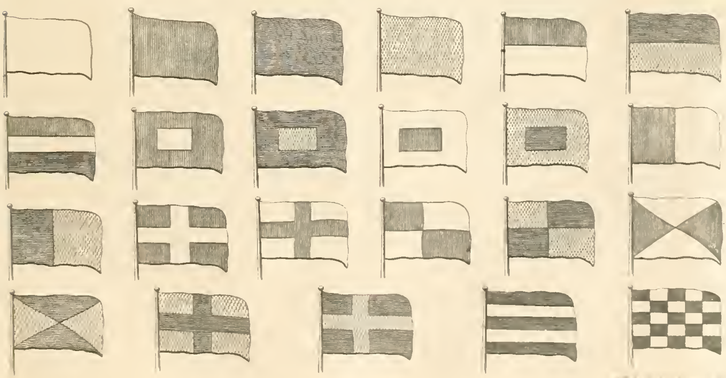


Fig. 2.



Naval SIGNALS.



Shooting.

than a fowling-piece ; but this is not owing to its length, but to its greater weight and thickneſs, which give it ſuch additional ſtrength, that the ſhot may be increaſed, and the charge of powder doubled, trebled, and even

3 **Proper length of the barrel**

quadrupled. But a barrel of five or ſix feet length would be very inconvenient for fowling. Thoſe who conſult the appearance of the piece, lightneſs, and the eaſe with which it is managed, will find that a barrel from 32 to 38 inches will anſwer beſt.

4 **Caliber.**

The next thing to be conſidered is, of what dimenſions the caliber or bore of a fowling-piece ought to be. This matter has been ſubjected to experiment, and it has been found, that a barrel of 22 or 24, which is the largeſt caliber uſually employed in fowling-pieces, throws its ſhot as cloſely as one of the ſmalleſt caliber, viz. of 30 or 32 (A).

5 **Length and form of the ſtock.**

As to the length and form of the ſtock, it may be laid down as a principle, that a long ſtock is preferable to a ſhort one, and at the ſame time rather more bent than uſual ; for a long ſtock fits firmer to the ſhoulder than a ſhort one, and particularly ſo when the ſhooter is accuſtomed to place his left hand, which principally ſupports the piece, near to the entrance of the ramrod into the ſtock.

It is certain, however, that the ſtock may be ſo formed as to be better ſuited to one man than another. For a tall, long-armed man, the ſtock of a gun ſhould be longer than for one of a leſs ſtature and ſhorter arm. That a ſtraight ſtock is proper for him who has high ſhoulders and a ſhort neck ; for, if it be much bent, it would be very difficult for him, eſpecially in the quick motion required in ſhooting at a flying or running object, to place the butt of the gun-ſtock firmly to the ſhoulder, the upper part alone would in general be fixed ; which would not only raiſe the muzzle, and conſequently ſhoot high, but make the recoil much more ſenſibly felt, than if the whole end of the ſtock were firmly placed on his ſhoulder. Beſides, ſuppoſing the ſhooter to bring the butt home to his ſhoulder, he would ſcarcely be able to level his piece at the object. On the contrary, a man with low ſhoulders, and a long neck, requires a ſtock much bent ; for if it is ſtraight, he will, in the act of lowering his head to that place of the ſtock at which his cheek ſhould reſt in taking aim, feel a conſtraint which he never experiences, when by the effect of the proper degree of bent, the ſtock lends him ſome aſſiſtance, and, as it were, meets his aim half way.

Having now deſcribed the fowling-piece which has been found to anſwer beſt, it will next be proper to give ſome inſtructions for the choice of gunpowder, ſhot, and wadding.

6 **Beſt gunpowder.**

The various kinds of gunpowder are well known ; but, in the opinion of ſome experienced ſportſmen, Hervey's battle-powder is the beſt. Thoſe who wiſh to examine the ſtrength of powder, may determine it by drying ſome of it very well, and then trying how many ſheets of paper it will drive the ſhot through, at the diſtance of 10 or 12 yards. In this trial we ſhould be careful to employ the ſame ſized ſhot in each experiment, the quantity both of the ſhot and the powder being regulated by exact weight ; otherwiſe we cannot, even in this experiment, arrive at any certainty in comparing the ſtrength of different powders, or of the ſame powder at different times.

7 **To be kept dry.**

Powder ought to be kept very dry, for every degree of moiſture injures it ; and if conſiderable, the ſaltpetre is diſſolved, and the intimate combination of the ſeveral ingredients is entirely deſtroyed. It is obſerved, that after firing with damp powder the piece becomes very foul, which ſeems to ariſe from the diminution of the activity of the fire in the exploſion. Flaſks of copper or tin are much better for keeping powder in than thoſe made of leather, or than ſmall caſks. Their necks ought to be ſmall and well ſtopped with cork.

8 **Size of ſhot.**

The *patent milled ſhot* is now very generally uſed, and is reckoned ſuperior to any other. The ſize of the ſhot muſt vary according to the particular ſpecies of game which is the object of the ſportſman's purſuit, as well as be adapted to the ſeaſon. In the firſt month of partridge ſhooting, N° 1. is moſt proper ; for ſince at this time the birds ſpring near at hand, and we ſeldom fire at more than the diſtance of 40 paces, if the ſhooter takes his aim but tolerably well, it is almoſt impoſſible for a bird at this diſtance to eſcape in the circle which the ſhot forms.

As hares ſit cloſer, and are thinly covered with fur at this ſeaſon, they may eaſily be killed with this ſhot at 30 or 35 paces. N° 1. is equally proper for ſhooting ſnipes or quails. About the beginning of October, when the partridges are ſtronger, N° 3. is the moſt proper ſhot to be uſed. Many ſportſmen uſe no other during the whole ſeaſon. The directions which have now been given refer only to the patent ſhot.

We ſhall now ſubjoin a table, which will ſhew at one view the number of pellets compoſing an ounce weight of each ſort of ſhot, the patent and the common, beginning with the ſmalleſt ſize.

PATENT SHOT.

N° 8.	1 ounce	620
7	id.	480
× (B)	id.	300
1	ib	220
2	id.	180
3	id.	157
4	id.	105
5	id.	83

COMMON SHOT.

N° 7.	1 ounce	350
6	id.	260
5	id.	235
4	id.	190
3	id.	140
2	id.	110
1	id.	95

9 **Proportion of powder and ſhot in the charge.**

For a fowling-piece of a common caliber, which is from 24 to 30 balls to the pound weight, a dram and a quarter,

(A) In ſpeaking of the ſize of the caliber, we mean by 22 or 24, that ſo many balls exactly fitting it weigh juſt one pound ; and every caliber is marked in the ſame way.

(B) The reader will obſerve that the patent ſhot has no N° 6, the × being ſubſtituted in its place, and that the numbers do not follow each other in the order of progreſſion : The reaſon of this we cannot aſſign.

Shooting. quarter, or at moſt a dram and a half, of good powder; and an ounce, or an ounce and a quarter of ſhot, is ſufficient. But when ſhot of a larger ſize is uſed, ſuch as N° 5. the charge of ſhot may be increaſed one-fourth, for the purpoſe of counterbalancing in ſome degree what the ſize of the ſhot loſes in the number of pellets, and alſo to enable it to garniſh the more. For this purpoſe the ſportſman will find a meaſure marked with the proper gauges very convenient to him. An inſtrument of this nature has been made by an ingenious artiſt of London, Egg, of the Haymarket.

A conſequence of overloading with ſhot, is the powder has not ſufficient ſtrength to throw it to its proper diſtance; for if the object fired at be diſtant, one-half of the pellets compoſing the charge, by their too great quantity and weight, will ſtrike againſt each other, and fall by the way; and thoſe which reach the mark will have ſmall force, and will produce but little or no effect.

10 Wadding. The uſe of the *wadding* is to carry the ſhot in a body to a certain diſtance from the muzzle of the piece. It ought to be of ſoft and pliable materials. The beſt kind of wadding, in the opinion of an experienced fowler, is a piece of an old hat; but this cannot be obtained in ſufficient quantity. Next to it nothing is better than ſoft brown paper, which combines ſuppleneſs with conſiſtence, moulds itſelf to the barrel, and never falls to the ground within 12 or 15 paces from the muzzle of the piece. Tow anſwers very well, and cork has been extolled for poſſeſſing the peculiar virtue of increaſing the range and cloſeneſs of the ſhot.

The wadding ought to be quite cloſe in the barrel, but not rammed too hard; for if it be rammed too cloſe, or be of a rigid ſubſtance, the piece will recoil, and the ſhot will ſpread too much. On the other hand, if the wadding be very looſe, or is compoſed of too ſoft materials, ſuch as wool or cotton, the diſcharge will not poſſeſs proper force.

11 Powder and ſhot to be ſlightly rammed down. In loading a piece, the powder ought to be ſlightly rammed down by only preſſing the ramrod two or three times on the wadding, and not by drawing up the ramrod and then returning it into the barrel with a jerk of the arm ſeveral times. For when the powder is violently compreſſed, ſome of the grains muſt be bruiſed, which will prevent the exploſion from being quick, and will ſpread the ſhot too wide. In pouring the powder into the barrel, the meaſure ought to be held ſo as that the powder may fall moſt readily to the bottom. That no grains may adhere to the ſides of the barrel, the butt-end of the piece may be ſtruck againſt the ground. The ſhot ought never to be rammed down with force: it is ſufficient to ſtrike the butt-end of the gun againſt the ground as before. Then the wadding is to be put down gently. A ſportſman ought never to carry his gun under his arm with the muzzle inclined downwards, for this practice looſens the wadding and charge too much.

12 Directions for loading and firing. Immediately after the piece is fired it ought to be reloaded; for while the barrel is ſtill warm, there is no danger of any moiſture lodging in it to hinder the powder from falling to the bottom. As it is found that the coldneſs of the barrel, and perhaps the moiſture condenſed in it, diminiſhes the force of the powder in the firſt ſhot; it is proper to fire off a little powder before the piece is loaded. Some prime before loading, but this is not proper unleſs the touch-hole be very large. After every diſcharge the touch-hole ought to be pricked, or a ſmall feather may be inſerted to clear away any humidity or foulneſs that has been contracted.

The ſportſman having loaded his piece, muſt next prepare to fire. For this purpoſe he ought to place his hand near the entrance of the ramrod, and at the ſame time graſp the barrel firmly. The muzzle ſhould be a little elevated, for it is more uſual to ſhoot low than high. This direction ought particularly to be attended to when the object is a little diſtant; becauſe ſhot as well as ball only moves a certain diſtance point blank, when it begins to deſcribe the curve of the parabola.

13 Diſtance at which the ſportſman ought to kill. Practice ſoon teaches the ſportſman the proper diſtance at which he ſhould ſhoot. The diſtance at which he ought infallibly to kill any kind of game with patent ſhot, N° 3. provided the aim be well taken, is from 25 to 35 paces for the footed, and from 40 to 45 paces for the winged, game. Beyond this diſtance even to 50 or 55 paces, both partridges and hares are ſometimes killed; but in general the hares are only ſlightly wounded, and carry away the ſhot; and the partridges at that diſtance preſent ſo ſmall a ſurface, that they frequently eſcape untouched between the ſpaces of the circle. Yet it does not follow that a partridge may not be killed with N° 3. patent ſhot at 60 and even 70 paces diſtance, but then theſe ſhots are very rare.

14 How the aim is to be taken. In ſhooting at a bird flying, or a hare running acroſs, it is neceſſary to take aim before the object in proportion to its diſtance at the time of firing. If a partridge flies acroſs at the diſtance of 30 or 35 paces, it will be ſufficient to aim at the head, or at moſt but a ſmall ſpace before it. If it be 50, 60, or 70 paces diſtant, it is then requiſite to aim at leaſt half a foot before the head. The ſame practice ought to be obſerved in ſhooting at a hare, rabbit, or fox, when running in a croſs direction; at the ſame time making due allowance for the diſtance and ſwiftneſs of the pace. Another thing to be attended to is, that the ſhooter ought not involuntarily to ſtop the motion of the arms at the moment of pulling the trigger; for the inſtant the hand ſtops in order to fire, however inconſiderable the time be, the bird gets beyond the line of aim, and the ſhot will miſs it. A ſportſman ought therefore to accuſtom his hand while he is taking aim to follow the object. When a hare runs in a ſtraight line from the ſhooter, he ſhould take his aim between the ears, otherwiſe he will run the hazard either of miſſing, or at leaſt not of killing dead, or as it is ſometimes called *clean*.

15 Every part of the piece to be kept clean and dry. A fowling-piece ſhould not be fired more than 20 or 25 times without being waſhed; a barrel when foul neither ſhoots ſo ready, nor carries the ſhot ſo far as when clean. The flint, pan, and hammer, ſhould be well wiped after each ſhot; this contributes greatly to make the piece go off quick, but then it ſhould be done with ſuch expedition, that the barrel may be reloaded whilſt warm, for the reaſons we have before advanced. The flint ſhould be frequently changed, without waiting until it miſſes fire, before a new one is put in. Fifteen or eighteen ſhots, therefore, ſhould only be fired with the ſame flint; the expence is too trifling to be regarded, and by changing it thus often much vexation will be prevented.

A gun alſo ſhould never be fired with the prime of the preceding day; it may happen that an old priming will ſometimes go off well, but it will more frequently contract moiſture and ſuze in the firing; then the object will moſt probably be miſſed, and that becauſe the piece was not freſh primed.

16 When and how game is to be ſought for.

For the information of the young ſportſman we ſhall add a few more general directions. In warm weather he ought to ſeek for game in plains and open grounds, and in cold weather he may ſearch little hills expoſed to the ſun, along hedges, among heath, in ſtubbles, and in paſtures where there is much furze and fern. The morning is the beſt time of the day, before the dew is exhaled, and before the game has been diſturbed. The colour of the ſhooters dreſs ought to be the ſame with that of the fields and trees; in ſummer it ought to be green, in winter a dark gray. He ought to hunt as much as poſſible with the wind, not only to prevent the game from perceiving the approach of him and his dog, but alſo to enable the dog to ſcent the game at a greater diſtance.

He ſhould never be diſcouraged from hunting and ranging the ſame ground over and over again, eſpecially in places covered with heath, brambles, high graſs, or young coppice wood. A hare or rabbit will frequently ſuffer him to paſs ſeveral times within a few yards of its form without getting up. He ſhould be ſtill more patient when he has marked partridges into ſuch places, for it often happens, that after the birds have been ſprung many times, they lie ſo dead that they will ſuffer him almoſt to tread upon them before they will riſe. Pheaſants, quails, and woodcocks do the ſame.

He ought to look carefully about him, never paſſing a buſh or tuft of graſs without examination; but he ought never to ſtrike them with the muzzle of his gun for it will looſen his wadding. He who patiently beats and ranges his ground over again, without being diſcouraged, will always kill the greateſt quantity of game; and if he is ſhooting in company, he will find game where others have paſſed without diſcovering any.

When he has fired he ſhould call in his dog, that he may not have the mortification to ſee game riſe which he cannot ſhoot. When he has killed a bird, inſtead of being anxious about picking it up, he ought to follow the reſt of the covey with his eye till he ſee them ſettle.

17 Dogs fit for ſport.

Three ſpecies of dogs are capable of receiving the proper inſtruction, and of being trained. Theſe are the ſmooth pointer, the ſpaniel, and the rough pointer. The laſt is a dog with long curled hair, and ſeems to be a mixed breed of the water-dog and the ſpaniel. The ſmooth pointer is active and lively enough in his range, but in general is proper only for an open country.

The greateſt part of theſe dogs are afraid of water, brambles, and thickets; but the ſpaniel and the rough pointer are eaſily taught to take the water, even in cold weather, and to range the woods and rough places as well as the plain. Greater dependence may therefore be had on theſe two laſt ſpecies of dogs than on the ſmooth pointer.

18 Directions for training a pointer.

The education of a pointer may commence when he is only five or ſix months old. The only leſſons which he can be taught at this time are to *fetch* and *carry* any thing when deſired; to come in when he runs far off, and to go behind when he returns; uſing, in the one caſe, the words *here*, *come in*, and in the other *back* or *behind*. It is alſo neceſſary at this period to accuſtom him to be tied up in the kennel or ſtable; but he ought not at firſt to be tied too long. He ſhould be let looſe in the morning, and faſtened again in the evening. When a dog is not early accuſtomed to be chained, he diſturbs every perſon in the neighbourhood by howling. It is alſo of importance that the perſon who is to train him ſhould give him his food.

When the dog has attained the age of 10 or 12 months, he may be carried into the field to be regularly trained. At firſt he may be allowed to follow his own inclination, and to run after every animal he ſees. His indiſcriminating eagerneſs will ſoon abate, and he will purſue only partridges and hares. He will ſoon become tired of following partridges in vain, and will content himſelf after having fluſhed them to follow them with his eyes. It will be more difficult to prevent him from following hares.

All young dogs are apt to *rake*; that is, to hunt with their noſes cloſe to the ground, to follow birds rather by the track than by the wind. But partridges lie much better to dogs that *wind* them, than to thoſe that follow them by the track. The dog that winds the ſcent approaches the birds by degrees and without diſturbing them; but they are immediately alarmed when they ſee a dog tracing their footſteps. When you perceive that your dog is committing this fault, call to him in an angry tone *hold up*: he will then grow uneaſy and agitated, going firſt to the one ſide and then to the other, until the wind brings him the ſcent of the birds After finding the *game* four or five times in this way, he will take the wind of himſelf, and hunt with his noſe high. If it be difficult to correct this fault, it will be neceſſary to put the *puzzle peg* upon him. This is of very ſimple conſtruction, conſiſting only of a piece of oak or deal inch board, one foot in length, and an inch and a half in breadth, tapering a little to one end; at the broader end are two holes running longitudinally, through which the collar of the dog is put, and the whole is buckled round his neck; the piece of wood being projected beyond his noſe, is then faſtened with a piece of leather thong to his under jaw. By this means the peg advancing ſeven or eight inches beyond his ſnout, the dog is prevented from putting his noſe to the ground and raking.

As ſoon as the young dog knows his game, you muſt bring him under complete ſubjection. If he is tractable, this will be eaſy; but if he is ſtubborn, it will be neceſſary to uſe the *traſh cord*, which is a rope or cord of 20 or 25 fathoms in length faſtened to his collar. If he refuſe to come back when called upon, you muſt check him ſmartly with the cord, which will often bring him upon his haunches. But be ſure you never call to him except when you are within reach of the cord. After repeating this ſeveral times he will not fail to come back when called; he ought then to be careſſed, and a bit of bread ſhould be given him. He ought now conſtantly to be tied up, and never unchained, except when you give him his food, and even then only when he has done ſomething to deſerve it.

The next ſtep will be to throw down a piece of bread on the ground, at the ſame moment taking hold of

Shooting. of the dog by the collar, calling out to him, "take heed,—foftly." After having held him in this manner for fome fpace of time, fay to him, "feize—lay hold." If he is impatient to lay hold of the piece of bread before the fignal is given, correct him gently with a fmall whip. Repeat this leffon until he "takes heed" well, and no longer requires to be held faft to prevent him from laying hold of the bread. When he is well accuftomed to this manége, turn the bread with a ftick, holding it in the manner you do a fowling-piece, and having done fo, cry *feize*. Never fuffer the dog to eat either in the houfe or field without having firft made him take heed in this manner.

Then, in order to apply this leffon to the game, fry fmall pieces of bread in hogs lard, with the dung of partridge; take thefe in a linen bag into the fields, ftubbles, ploughed grounds, and paftures, and there put the pieces in feveral different places, marking the fpots with little cleft pickets of wood, which will be rendered more diftinguifhable by putting pieces of card in the nicks. This being done, caft off the dog and conduct him to thefe places, always hunting in the wind. After he has caught the fcent of the bread, if he approaches too near, and feems eager to fall upon it, cry to him in a menacing tone, "take heed;" and if he does not ftop immediately, correct him with the whip. He will foon comprehend what is required of him, and will ftand.

At the next leffon, take your gun charged only with powder, walk gently round the piece of bread once or twice, and fire inftead of crying *feize*. The next time of practifing this leffon, walk round the bread four or five times, but in a greater circle than before, and continue to do this, until the dog is conquered of his impatience, and will ftand without moving until the fignal is given him. When he keeps his point well, and ftands fteady in this leffon, you may carry him to the birds; if he run in upon them, or bark when they fpring up, you muft correct him; and if he continue to do fo, you muft return to the fried bread; but this is feldom neceffary.

When the dog has learned by this ufe of the bread to take heed, he may be carried to the fields with the trafh-cord dragging on the ground. When he fprings birds for the firft time, if he runs after them or barks, check him by calling out to him, *take heed*. If he point properly, carefs him; but you ought never to hunt without the cord until he point ftaunch.

19 and preventing his running after fheep.

If the dog runs after fheep, and it be difficult to cure him, couple him with a ram, and then whip the dog as long as you can follow him. His cries will at firft alarm the ram; he will run with all his fpeed, and drag the dog along with him; but he will at length take courage, turn upon the dog, and butt him feverely with his horns. When you think the dog is fufficiently chaftifed, untie him: he will never run at fheep again.

Having now given a few general inftructions concerning the beft method of training pointers, we fhall fubjoin a few obfervations refpecting the moft common fpecies of game, the partridge, pheafant, groufe, woodcock, fnipe, and wild duck.

20 Obfervations concerning the partridge.

Partridges pair in the fpring, and lay their eggs (generally from 15 to 20) during May and part of June. The young begin to fly about the end of June, and their plumage is complete in the beginning of October. The male has a confpicuous horfe fhoe upon his breaft, an obtufe fpur on the hinder part of the leg, which diftinguifh him from the female. He is alfo rather larger.

When a fportfman is fhooting in a country where the birds are thin, and he no longer choofes to range the field for the bare chance of meeting with them, the following method will fhow him where to find them on another day. In the evening, from funfet to nightfall, he fhould poft himfelf in a field, at the foot of a tree or a bufh, and there wait until the partridges begin to call or juck, which they always do at that time; not only for the purpofe of drawing together when feparated, but alfo when the birds compofing the covey are not difperfed. After calling in this manner for fome little fpace of time, the partridges will take to flight; then, if he mark the place where they alight, he may be affured they will lie there the whole night, unlefs difturbed. Let him return to the fame poft the next morning by break of day, and there watch a while; being careful to keep his dog in a ftring, if he is not under perfect command.

As foon as the dawn begins to peep, the partridges will begin to call, and foon afterwards will perform the fame manœuvre as on the preceding evening; that is, after having called a while, they will take their flight, and will moft commonly fettle at a little diftance. There in a few minutes they will call again, and fometimes take a fecond flight, but that will be to no great diftance. Then as foon as the fun is rifen, and the fportfman can fee to fhoot, he may caft off his dog and purfue them.

21 Pheafant.

The *pheafant* is of the fize of a common dunghill cock, and lays its eggs generally in the woods, the number of which is 10 or 12.

Pheafants are accounted ftupid birds; for when they are furprifed they will frequently fquat down like a rabbit, fuppofing themfelves to be in fafety as foon as their heads are concealed; and in this way they will fometimes fuffer themfelves to be killed with a ftick. They love low and moift places, and haunt the edges of thofe pools which are in found in woods, as well as the high grafs of marfhes that are near at hand; and above all, places where there are clumps of alders.

22 Groufe.

Groufe, or moor-game, are found in Wales, in the northern counties of England, and in great abundance in Scotland. They chiefly inhabit thofe mountains and moors which are covered with heath, and feldom defcend to the low grounds. They fly in companies of four or five braces, and love to frequent moffy places, particularly in the middle of the day or when the weather is warm. In purfuing this game, when the pointer fets, and the fportfman perceives the birds running with their heads erect, he muft run after them as faft as he can, in the hope that he may get near enough to fhoot when they rife upon the wing; for he may be pretty certain they will not lie well that day. As thefe birds are apt to grow foon putrid, they ought to be drawn carefully the inftant they are fhot and ftuffed with any heath, and if the feathers happen to be wetted they muft be wiped dry.

23 Woodcock.

The *woodcock* is a bird of paffage; it commonly arrives about the end of October, and remains until the middle of March. Woodcocks are fatteft in December and January, but from the end of February they are lean. At their arrival they drop anywhere, but afterwards

wards take up their reſidence in copſes of nine or ten years growth. They ſeldom, however, ſtay in one place longer than 12 or 15 days. During the day, they remain in thoſe parts of the woods where there are void ſpaces or glades, picking up earth-worms and grubs from the fallen leaves. In the evening they go to drink and waſh their bills at pools and ſprings, after which they repair to the open fields and meadows for the night. It is remarkable, that when a woodcock ſprings from a wood to go into the open country, he always endeavours to find ſome glade or opening, which he follows to the boundaries of the wood. At his return he purſues the ſame path a good way, and then turns to the right or left oppoſite to ſome glade, in order to drop into a thick part of the wood, where he may be ſheltered from the wind. He may therefore be watched with advantage in theſe narrow paſſes and little alleys on the edges of woods which lead to a pool or ſpring, or he may be watched in the duſk of the evening near the pools which he frequents.

24 Snipe. The *ſnipe* is a bird of paſſage as well as the woodcock. This bird is ſcarcely worth ſhooting till the froſt commences. In the month of November they begin to grow fat. Snipes, like woodcocks, frequent ſprings, bogs, and marſhy places, and generally fly againſt the wind. The ſlant and croſs ſhots are rather difficult, as the birds are ſmall and fly very quickly. The ſportſman ought to look for them in the direction of the wind; becauſe then they will fly towards him, and preſent a fairer mark.

25 Wild duck. The *wild duck* is alſo a bird of paſſage, and arrives here in great flocks from the northern countries in the beginning of winter. Still, however, a great many remain in our marſhes and fens during the whole year, and breed.

The wild duck differs little in plumage from the tame duck, but is eaſily diſtinguiſhed by its ſize, which is leſs; by the neck, which is more ſlender; by the foot, which is ſmaller; by the nails, which are more black; and above all, by the web of the foot, which is much finer and ſofter to the touch.

In the ſummer ſeaſon, when it is known that a team of young ducks are in a particular piece of water, and juſt beginning to fly, the ſportſman is ſure to find them early in the morning dabbling at the edges of the pool, and amongſt the long graſs, and then he may get very near to them: it is uſual alſo to find them in thoſe places at noon.

In the beginning of autumn almoſt every pool is frequented by teams of wild ducks, which remain there during the day, concealed in the ruſhes. If theſe pools are of ſmall extent, two ſhooters, by going one on each ſide, making a noiſe and throwing ſtones into the ruſhes, will make them fly up; and they will in this way frequently get ſhots, eſpecially if the pool is not broad, and contracts at one end. But the ſureſt and moſt ſucceſsful way, is to launch a ſmall boat or trow on the pool, and to traverſe the ruſhes by the openings which are found; at the ſame time making as little noiſe as poſſible. In this manner the ducks will ſuffer the ſportſmen to come ſufficiently near them to ſhoot flying; and it often happens that the ducks, after having flown up, only make a circuit, return in a little time, and again alight upon the pool. Then the ſportſmen endeavour a ſecond time to come near them. If ſeveral ſhooters are in company, they ſhould divide; two ſhould go in the boat, whilſt the others ſpread themſelves about the edge of the pool, in order to ſhoot the ducks in their flight. In pools which will not admit a trow, water-ſpaniels are abſolutely neceſſary for this ſport.

In winter they may be found on the margins of little pools; and when pools and rivers are frozen up, they muſt be watched for in places where there are ſprings and waters which do not freeze. The ſport is then much more certain, becauſe the ducks are confined to theſe places in order to procure aquatic herbs, which are almoſt their only food at this period.

SHOP-LIFTERS, are thoſe that ſteal goods privately out of ſhops; which, being to the value of 5s. though no perſon be in the ſhop, is felony without the benefit of clergy by the 10 and 11 W. III. c. 23.

SHORE, a place waſhed by the ſea, or by ſome large river.

Count Marſigli divides the ſea-ſhore into three portions: the firſt of which is that tract of land which the ſea juſt reaches in ſtorms and high tides, but which it never covers; the ſecond part of the ſhore is that which is covered in high tides and ſtorms, but is dry at other times; and the third is the deſcent from this, which is always covered with water.

The firſt part is only a continuation of the continent, and ſuffers no alteration from the neighbourhood of the ſea, except that it is rendered fit for the growth of ſome plants, and wholly unfit for that of others, by the ſaline ſteams and impregnations: and it is ſcarce to be conceived by any, but thoſe who have obſerved it, how far on land the effects of the ſea reach, ſo as to make the earth proper for plants which will not grow without this influence; there being ſeveral plants frequently found on high hills and dry places, at three, four, and more miles from the ſea, which yet would not grow unleſs in the neighbourhood of it, nor will ever be found elſewhere.

The ſecond part or portion of the ſhore is much more affected by the ſea than the former, being frequently waſhed and beaten by it. Its productions are rendered ſalt by the water, and it is covered with ſand, or with the fragments of ſhells in form of ſand, and in ſome places with a tartarous matter depoſited from the water; the colour of this whole extent of ground is uſually duſky and dull, eſpecially where there are rocks and ſtones, and theſe covered with a ſlimy matter.

The third part of the ſhore is more affected by the ſea than either of the others; and is covered with an uniform cruſt of the true nature of the bottom of the ſea, except that plants and animals have their reſidence in it, and the decayed parts of theſe alter it a little.

SHORE, *Jane*, the celebrated concubine of the licentious King Edward IV. was the wife of Mr Matthew Shore, a goldſmith in Lombard-ſtreet, London. Kings are ſeldom unſucceſsful in their amorous purſuits; therefore there was nothing wonderful in Mrs Shore's removing from Lombard-ſtreet to ſhine at court as the royal favourite. Hiſtorians repreſent her as extremely beautiful, remarkably cheerful, and of moſt uncommon generoſity. The king, it is ſaid, was no leſs captivated with her temper than with her perſon: ſhe never made uſe of her influence over him to the prejudice of any perſon; and if ever ſhe importuned him, it was in favour of the unfortunate. After the death of Edward, she attached herself to the lord Hastings; and when Richard III. cut off that nobleman as an obstacle to his ambitious schemes, Jane Shore was arrested as an accomplice, on the ridiculous accusation of witchcraft. This, however, terminated only in a public penance; excepting that Richard rifled her of all her little property: but whatever severity might have been exercised towards her, it appears that she was alive, though sufficiently wretched, under the reign of Henry VIII. when Sir Thomas More saw her poor, old, and shrivelled, without the least trace of her former beauty. Mr Rowe, in his tragedy of Jane Shore, has adopted the popular story related in the old historical ballad, of her perishing by hunger in a ditch where Shoreditch now stands. But Stow assures us that street was so named before her time.

SHORL. See SCHORL, MINERALOGY *Index*.

SHORLING and MORLING, are words to distinguish fells of sheep; *shorling* being the fells after the fleeces are shorn off the sheep's back; and *morling*, the fells flead off after they die or are killed. In some parts of England they understand by a *shorling*, a sheep whose face is shorn off; and by a *morling*, a sheep that dies.

SHORT, JAMES, an eminent optician, was born in Edinburgh on the 10th of June, O. S. in the year 1710. At ten years of age, having lost his father and mother, and being left in a state of indigence, he was received into Heriot's Hospital, (see *EDINBURGH, Public Buildings*, N° 16.), where he soon displayed his mechanical genius in constructing, for himself, little chests, bookcases, and other conveniences, with such tools as fell in his way. At the age of twelve he was removed from the Hospital to the High School, where he showed a considerable taste for classical literature, and generally kept at the head of his forms. In the year 1726 he was entered into the university, where he passed through the usual course of education, and took his master's degree with great applause.

By his friends he was intended for the church; but after attending a course of theological lectures, his mind revolted from a profession which he thought little suited to his talents; and he devoted his whole time to mathematical and mechanical pursuits He had been fortunate enough to have the celebrated M'Laurin for his preceptor; who having soon discovered the bent of his genius, and made a proper estimate of the extent of his capacity, encouraged him to prosecute those studies in which nature had qualified him to make the greatest figure. Under the eye of that eminent master, he began in 1732 to construct Gregorian telescopes; and, as the professor observed in a letter to Dr Jurin, "by taking care of the figure of his specula, he was enabled to give them larger apertures, and to carry them to greater perfection, than had ever been done before him." (See OPTICS, N° 89.).

In the year 1736 Mr Short was called to London, at the desire of Queen Caroline, to give instructions in mathematics to William duke of Cumberland; and immediately on his appointment to that very honourable office he was elected a fellow of the royal society, and patronized by the earls of Morton and Macclesfield. In the year 1739 he accompanied the former of those noble lords to the Orkney isles, where he was employed in adjusting the geography of that part of Scotland; and happy it was for him that he was so employed, as he might otherwise have been involved in a scuffle which took place between the retainers of Sir James Stewart of Barra and the attendants of the earl, in which some of the latter were dangerously wounded.

Mr Short having returned to London, and finally established himself there in the line of his profession, was in 1742 employed by Lord Thomas Spencer to make for him a reflector of twelve feet focus, for which he received 600 guineas. He made several other telescopes of the same focal distance with greater improvements and higher magnifiers; and in 1752 finished one for the king of Spain, for which, with its whole apparatus, he received 1200l. This was the noblest instrument of the kind that had then been constructed, and perhaps it has never yet been surpassed except by the astonishing reflectors of Herschel. See TELESCOPE.

Mr Short used to visit the place of his nativity once every two or three years during his residence in London, and in 1766 he visited it for the last time. On the 15th of June 1768 he died, after a very short illness, at Newington Butts, near London, of a mortification in his bowels, and was buried on the 22d of the same month, having completed, within a few days, his fifty-eighth year. He left a fortune of about 20,000l. of which 15,000l. was bequeathed to two nephews, and the rest in legacies to his friends. In gratitude for the steady patronage of the earl of Morton, he left to his daughter the lady Mary Douglas, afterwards countess of Aboyne, 1000l. and the reversion of his fortune, should his nephews die without issue; but this reversionary legacy the lady, at the desire of her father, generously relinquished by a deed in favour of Mr Short's brother Mr Thomas Short and his children. Mr Short's eminence as an artist is universally known, and we have often heard him spoken of by those who were acquainted with him from his youth, as a man of virtue and of very amiable manners.

SHORT-Hand Writing. See STENOGRAPHY.

SHORT-Jointed, in the *Manege*. A horse is said to be short jointed that has a short pastern; when this joint, or the pastern is too short, the horse is subject to have his fore legs from the knee to the cornet all in a straight line. Commonly your short-jointed horses do not manege so well as the long-jointed; but out of the manege the short-jointed are the best for travel or fatigue.

SHORT Sightedness, a certain defect in vision, by which objects cannot be distinctly seen unless they are very near the eye. See OPTICS, N° 142.

SHORTFORD, q. d. *fore-close*, an ancient custom in the city of Exeter, when the lord of the fee cannot be answered rent due to him out of his tenement, and no distress can be levied for the same. The lord is then to come to the tenement, and there take a stone, or some other dead thing off the tenement, and bring it before the mayor and bailiff, and thus he must do seven quarter days successively; and if on the seventh quarter-day the lord is not satisfied of his rent and arrears, then the tenement shall be adjudged to the lord to hold the same a year and a day; and forthwith proclamation is to be made in the court, that if any man claims any title to the said tenement, he must appear within the year and day next following, and satisfy the lord of the said rent and arrears: but if no appearance be made, and the rent not paid, the lord comes again to the court,

court, and prays that, according to the cuftom, the faid tenement be adjudged to him in his demefne as of fee, which is done accordingly, fo that the lord hath from thenceforth the faid tenement, with the appurtenances to him and his heirs.

SHOT, a denomination given to all forts of balls for fire-arms: thofe for cannon being of iron, and thofe for guns, piftols, &c. of lead. See SHOOTING.

Cafe SHOT formerly confifted of all kinds of old iron, nails, mufket-balls, ftones, &c. ufed as above.

SHOT of a Cable, on fhip-board, is the fplicing of two cables together, that a fhip may ride fafe in deep waters and in great roads; for a fhip will ride eafier by one fhot of a cable, than by three fhort cables out ahead.

Grape-SHOT. See *GRAPE-Shot.*

Patent-milled SHOT is thus made: Sheets of lead, whofe thicknefs correfponds with the fize of the fhot required, are cut into fmall pieces, or cubes, of the form of a die. A great quantity of thefe little cubes are put into a large hollow iron cylinder, which is mounted horizontally and turned by a winch; when by their friction againft one another and againft the fides of the cylinder, they are rendered perfectly round and very fmooth. The other patent fhot is caft in moulds, in the fame way as bullets are.

SHOT Flaggon, a fort of flaggon fomewhat bigger than ordinary, which in fome counties, particularly Derbyfhire, it is the cuftom for the hoft to ferve his guefts in, after they have drank above a fhilling.

Small SHOT, or that ufed for fowling, fhould be well fized, and of a moderate bignefs: for fhould it be too great, then it flies thin, and fcatters too much; or if too fmall, then it hath not weight and ftrength to penetrate far, and the bird is apt to fly away with it. In order, therefore, to have it fuitable to the occafion, it not being always to be had in every place fit for the purpofe, we fhall fet down the true method of making all forts and fizes under the name of *mould-fhot*. Its principal good properties are to be round and folid.

Take any quantity of lead you think fit, and melt it down in an iron veffel; and as it melts keep it ftirring with an iron ladle, fkimming off all impurities whatfoever that may arife at the top: when it begins to look of a greenifh colour, ftrew on it as much auripigmentum or yellow orpiment, finely powdered, as will lie on a fhilling, to every 12 or 14 pound of lead; then ftirring them together, the orpiment will flame.

The ladle fhould have a notch on one fide of the brim, for more eafily pouring out the lead; the ladle muft remain in the melted lead, that its heat may be the fame with that of the lead, to prevent inconveniences which otherwife might happen by its being either too hot or too cold: then, to try your lead, drop a little of it into water, and if the drops prove round, then the lead is of a proper heat; if otherwife, and the fhot have tails, then add more orpiment to increafe the heat, till it be found fufficient.

Then take a plate of copper, about the bignefs of a trencher, which muft be made with a hollownefs in the middle, about three inches compafs, within which muft be bored about 40 holes according to the fize of the fhot which you intend to caft: the hollow bottom fhould be thin; but the thicker the brim, the better it will retain the heat. Place this plate on a frame of iron, over a tub or veffel of water, about four inches from the water, and fpread burning coals on the plate, to keep the lead melted upon it: then take fome lead and pour it gently on the coals on the plate, and it will make its way through the holes into the water, and form itfelf into fhot; do this till all your lead be run through the holes of the plate, taking care, by keeping your coals alive, that the lead do not cool, and fo ftop up the holes.

While you are cafting in this manner, another perfon with another ladle may catch fome of the fhot, placing the ladle four or five inches underneath the plate in the water, by which means you will fee if they are defective, and rectify them.

Your chief care is to keep the lead in a juft degree of heat, that it be not fo cold as to ftop up the holes in your plate, nor fo hot as to caufe the fhot to crack: to remedy the heat, you muft refrain working till it is of a proper coolnefs; and to remedy the coolnefs of your lead and plate, you muft blow your fire; obferving, that the cooler your lead is, the larger will be your fhot; as the hotter it is, the fmaller they will be.

After you have done cafting, take them out of the water, and dry them over the fire with a gentle heat, ftirring them continually that they do not melt; when dry, you are to feparate the great fhot from the fmall, by the help of a fieve made for that purpofe, according to their feveral fizes. But thofe who would have very large fhot, make the lead trickle with a ftick out of the ladle into the water, without the plate.

If it ftop on the plate, and yet the plate be not too cool, give but the plate a little knock, and it will run again; care muft be had that none of your implements be greafy, oily, or the like; and when the fhot, being feparated, are found too large or too fmall for your purpofe, or otherwife imperfect, they will ferve again at the next operation.

The fizes of common fhot for fowling are from N° 1 to 6, and fmaller, which is called muftard feed, or duft fhot; but N° 5 is fmall enough for any fhooting whatfoever. The N° 1 may be ufed for wild geefe; the N° 2 for ducks, widgeons, and other water-fowl; the N° 3 for pheafants, partridges after the firft month, and all the fen-fowl; the N° 4 for partridges, woodcocks, &c.; and the N° 5 for fnipes and all the fmaller birds.

Tin-Cafe SHOT, in artillery, is formed by putting a great quantity of fmall iron fhot into a cylindrical tin-box called a cannifter, that juft fits the bore of the gun. Leaden bullets are fometimes ufed in the fame manner; and it muft be obferved, that whatever number or fizes of the fhots are ufed, they muft weigh with their cafes nearly as much as the fhot of the piece.

SHOVEL, SIR CLOUDESLY, was born about the year 1650 of parents rather in the lower rank of life. He was put apprentice to a fhoemaker; but difliking this profeffion, he abandoned it a few years after, and went to fea. He was at firft a cabin boy with Sir Chriftopher Mynns, but applying to the ftudy of navigation with indefatigable induftry, his fkill as a feaman foon raifed him above that ftation.

The corfairs of Tripoli having committed great outrages on the Englifh in the Mediterranean, Sir John Narborough was fent in 1674 to reduce them to reafon. As he had received orders to try the effects of negociation before he proceeded to hoftilities, he fent Mr Shovel,

Shovel, who was at that time a lieutenant in his fleet, to demand satisfaction. The Dey treated him with a great deal of disrespect, and sent him back without an answer. Sir John dispatched him a second time, with orders to remark particularly the situation of things on shore. The behaviour of the Dey was worse than ever. Upon Mr Shovel's return, he informed Sir John that it would be possible, notwithstanding their fortifications, to burn all the ships in the harbour. The boats were accordingly manned, and the command of them given to Lieut. Shovel, who seized the guardship, and burnt four others, without losing a man. This action so terrified the Tripolins, that they sued for peace.—Sir John Narborough gave so favourable an account of this exploit, that Mr Shovel was soon after made captain of the Sapphire, a fifth rate ship.

In the battle of Bantry-Bay, after the revolution, he commanded the Edgar, and, for his gallant behaviour in that action, was soon after knighted by King William. Next year he was employed in transporting an army into Ireland; a service which he performed with so much diligence and dexterity, that the king raised him to the rank of rear-admiral of the blue, and delivered his commission with his own hands. Soon after he was made rear-admiral of the red, and shared the glory of the victory at La Hogue. In 1694, he bombarded Dunkirk. In 1703, he commanded the grand fleet in the Mediterranean, and did every thing in his power to assist the Protestants who were in arms in the Cevennes.

Soon after the battle off Malaga, he was presented by Prince George to Queen Anne, who received him graciously, and next year employed him as commander in chief.

In 1705 he commanded the fleet, together with the earls of Peterborough and Monmouth, which was sent into the Mediterranean; and it was owing to him chiefly that Barcelona was taken. After an unsuccessful attempt upon Toulon, he sailed for Gibraltar, and from thence homeward with a part of the fleet. On the 22d of October, at night, his ship, with three others, was cast away on the rocks of Scilly. All on board perished. His body was found by some fishermen on the island of Scilly, who stripped it of a valuable ring, and afterwards buried it. Mr Paxton, the purser of the Arundel, hearing of this, found out the fellows, and obliged them to discover where they had buried the body. He carried it on board his own ship to Portsmouth, from whence it was conveyed to London, and interred with great solemnity in Westminster Abbey. A monument was afterwards erected to his memory by the direction of the queen. He married the widow of his patron, Sir John Narborough, by whom he left two daughters, co-heiresses.

SHOVELER, a species of ANAS. See ANAS, ORNITHOLOGY *Index*.

SHOULDER-BLADE, a bone of the shoulder, of a triangular figure, covering the hind part of the ribs, called by anatomists the *scapula* and *omoplata*. See ANATOMY.

SHOUT, CLAMOUR, in antiquity, was frequently used on ecclesiastical, civil, and military occasions, as a sign of approbation, and sometimes of indignation.—Thus as Cicero, in an assembly of the people, was exposing the arrogance of L. Antony, who had had the impudence to cause himself to be inscribed the patron of the Romans, the people on hearing this raised a shout to show their indignation. In the ancient military discipline, shouts were used, 1. Upon occasion of the general's making a speech or harangue to the army from his tribunal. This they did in token of their approving what had been proposed. 2. Before an engagement, in order to encourage and spirit their own men, and fill the enemy with dread. This is a practice of great antiquity; besides which, it wants not the authority of reason to support it; for as mankind are endowed with two senses, hearing and seeing, by which fear is raised in the mind, it may be proper to make use of the ear as well as the eye for that purpose. Shouts were also raised in the ancient theatre, when what was acted pleased the spectators. It was usual for those present at the burning of the dead to raise a great shout, and call the dead person by his name before they set fire to the pile.

SHOWER, in *Meteorology*, a cloud condensed into RAIN.

SHREWMOUSE. See SOREX, MAMMALIA *Index*.

SHREWSBURY, the capital of Shropshire in England. This town, the metropolis of the county, grew up out of the ruins of Uriconium, anciently a city, now a village called *Wroxeter*, about four miles from it. The Saxons called it *Scrobbes Berig*, from the shrubs that grew about it; and from thence the present name of *Shrewsbury* is supposed to have been formed. It is pleasantly situated upon a hill near the Severn, over which there are two handsome bridges. It was a place of note in the Saxon times; after which it was granted by William the Conqueror, together with the title of *earl* and most of the county, to Roger de Montgomery, who built a castle upon the north side of it, where the Severn, that encompasses it on all other sides, leaves an opening. His son Robert built also a wall across this neck of land, when he revolted from Henry I. We learn from doomsday-book, that at that time, when a widow of this town married, she paid 20 shillings to the king, and a virgin 10. The above-mentioned Roger founded also, and endowed here, a Benedictine monastery and a collegiate church. When old age came upon him, he quitted the world, and spent the rest of his days as a monk in the abbey, and when he died was interred in its church. From the history of this church and monastery, it appears that ecclesiastical benefices about that time were hereditary. The abbey became so rich afterwards, that the abbot was mitred, and sat in parliament. Besides this abbey, in after times there were three others, viz. a Franciscan, Dominican, and Augustin; and likewise two collegiate churches, one dedicated to St Chad and the other to St Mary. In the contest between the empress Maud and Stephen, this town and its governor William Fitz-Allan sided with the empress. In Henry III.'s time, a part of it was burnt down by the Welch; and in Richard II.'s reign a parliament was held in it. At a place called *Battle-field*, near this town, Henry Percy the younger, surnamed *Hotspur*, was killed in an engagement with Henry IV. against whom he had rebelled. The king afterwards built a chapel upon the spot, and endowed it for the support of two priests to pray for the souls of the slain. Two of Edward IV.'s sons were born here; namely,

namely, Richard, duke of York, whom Perkin Warbeck afterwards perfonated, and who was murdered in the Tower; and George Plantagenet, who died before his brothers. Here firft broke out the fweating ficknefs, which carried off great numbers fo fuddenly, that thofe who were feized with it either died or recovered in the fpace of 24 hours. In the beginning of the civil wars, King Charles I. came hither, and formed an army, with which he marched towards London; but was met by the parliament's forces at Edgehill. He continued here from the 20th of September to the 12th of October, during which time he was joined by Prince Rupert, and many of the gentry and nobility of thefe parts. This town anciently gave title of earl to the Montgomeries, and afterwards to the Talbots, by whom it is ftill retained. Here is a free grammar-fchool, with three mafters, and feveral ufhers, well endowed by Edward VI. and Queen Elizabeth, and not inferior to many colleges in the univerfities. It has a good library and chapel, and there are feveral fcholarfhips appropriated to it in the univerfity of Cambridge. Here are alfo feveral hofpitals, alms-houfes, and charity-fchools. This town is one of the moft flourifhing in England, having two great weekly markets for corn, cattle, and provifions; and another for Welch cottons and flannels, of which great quantities are fold. A great trade is carried on with the Welch, who bring their commodities hither, as to the common mart of both nations. The town is large and well-built, and the fituation extremely pleafant. There is a very beautiful walk called the *quarry*, between the town walls and the Severn, delightfully fhaded with rows of lime-trees, fo that it is not inferior to the Mall in St James's Park. The town is alfo noted for its gallantry and politenefs, being full of gentry, for whom there are always balls and affemblies once a-week all the year round.—Here is a fine houfe and gardens, which belonged to the earl of Bradford; and in the neighbourhood, at Wroxeter, the Roman highway, called Watling-ftreet, may be feen for feveral miles, where Roman coins are frequently found. In Shrewfbury are 12 incorporated trading companies; and the corporation has a power to try even capital caufes of itfelf, except high treafon. It is faid that thigh-bones of dead men have been found here a yard long, and teeth three inches round and three long.

SHRIKE. See Lanius, Ornithology *Index*.

SHRIMP. See Cancer, Entomology *Index*.

SHRINE, in *Ecclefiaftical Hiftory*, a cafe or box to hold the relics of fome faint.

SHROPSHIRE, a county of England, bounded on the fouth by Worcefterfhire, Herefordfhire, and Radnorfhire; on the north, by Chefhire; on the eaft, by Staffordfhire; on the weft, by Montgomeryfhire and Denbighfhire, in Wales. Its length is between 49 and 50 miles, its breadth about 38, and its circumference about 210. It is an inland county, containing 890,000 acres, 167,639 inhabitants, and 15 hundreds, in which are 170 parifhes, and 15 market towns. It makes a part of three bifhoprics, viz. Hereford, Coventry and Litchfield, and St Afaph. Some part of it lies on the north, and fome on the fouth fide of the Severn. Befides the Severn, it is alfo watered by the *Temd* or *Tefidiauc*, as it is called in Welch, which flows from the mountains of Radnorfhire; and by the Tern, which has its rife and name from one of thofe pools called *tearnes*, in Staffordfhire. All thefe abound with fifh, efpecially trouts, pikes, lampreys, graylings, carp, and eels. The air, efpecially upon the hills, with which the county abounds, is very wholefome. There is as great a diverfity of foil as in moft other counties. On the hills, where it is poor, is very good pafture for fheep; and in the low grounds, where it is very rich, along the Severn in particular, there is plenty of grafs for bay and black cattle, with all forts of corn. This county is abundantly provided with fuel, having in it many extenfive mines of coal; it has alfo mines of lead and iron. Over moft of the coal-pits in this county lies a ftratum or layer of blackifh porous rock, of which, by grinding and boiling, they make pitch and tar, which are rather better than the common fort for caulking fhips, as they do not crack, but always continue clofe and fmooth. Quarries of lime-ftone and iron-ftone are common in the county, and the foil in many places is a reddifh clay. The abundance of coal and iron-ftone in this county has given rife to numerous manufactories.

As it lies upon the borders of Wales, it was anciently full of caftles and walled towns. On the fide next that country there was an almoft continued line of caftles, to guard the county againft the inroads and depredations of the Welch. The borders here, as thofe between England and Scotland, were called *marches*, and there were certain noblemen entitled *barones marchiæ*, *marchiones de marchia Walliæ*, " lords of the marches, or marquiffes of the marches of Wales," who were vefted with a fort of palatine jurifdiction, held courts of juftice to determine controverfies, and enjoyed many privileges and immunities, the better to enable and encourage them to protect the county againft the incurfions of the Welch, and to maintain order amongft the borderers; but they often abufed their power, and were the greateft of tyrants.

As to the ecclefiaftical government of the county, the far greater part, namely, all that belongs to the bifhoprics of Hereford, and of Litchfield and Coventry, is under the jurifdiction and vifitation of the archdeacon of Shrewfbury or Salop, and is divided into feveral deanries.

The Oxford circuit includes in it this county, which fends 12 members to parliament, viz. two for the fhire, and two for each of the following towns, Shrewfbury, Ludlow, Wenlock, and Bifhop's Caftle.

SHROVE-Tuesday, is the Tuefday after Quinquagefima Sunday, or the day immediately preceding the firft of Lent; being fo called from the Saxon word *fhrive*, which fignifies " to confefs." Hence Shrove-Tuefday fignifies Confeffion-Tuefday; on which day all the people in every parifh throughout England (during the Romifh times) were obliged to confefs their fins, one by one, to their own parifh-priefts, in their own parifh-churches; and, that this might be done the more regularly, the great bell in every parifh was rung at ten o'clock (or perhaps fooner), that it might be heard by all, and that they might attend, according to the cuftom then in ufe. And though the Romifh religion has now given way to the Proteftant religion, the cuftom of ringing the great bell in our ancient parifh-churches, at leaft in fome of them, ftill remains, and obtains in and about London the name of Pancake bell; perhaps, becaufe after the confeffion it was cuftomary for the feveral perfons to dine on pancakes or fritters. Moft churches,

churches, indeed, have rejected that cuftom of ringing the bell on Shrove-Tuefday; but the ufage of dining on pancakes or fritters, and fuch like provifion, ftill continues.

SHROUDS (*fcrud* Sax.), a range of large ropes extending from the maft heads to the right and left fide of the fhip, to fupport the mafts, and enable them to carry fail, &c.

The fhrouds as well as the fails are denominated from the mafts to which they belong. Thus they are the main, fore, and mizen fhrouds; the main-top-maft, fore-top-maft, or mizen-top maft fhrouds; and the main-top-gallant, fore-top-gallant, or mizen-top-gallant fhrouds. The number of fhrouds by which a maft is fuftained, as well as the fize of rope of which they are formed, is always in proportion to the fize of the maft and the weight of the fail it is intended to carry.

Bowfprit fhrouds are thofe which fupport the bowfprit. Bumkin fhrouds are thofe which fupport the bumkins. Futtock fhrouds are fhrouds which connect the efforts of the topmaft fhrouds to the lower fhrouds. Bentinck fhrouds are additional fhrouds to fupport the mafts in heavy gales. Preventer fhrouds are fimilar to bentinck fhrouds, and are ufed in bad weather to eafe the lower rigging. See MAST and SAIL.

SHRUB, *frutex*, a little, low, dwarf tree, or a woody vegetable, of a fize lefs than a tree; and which, inftead of one fingle ftem, frequently from the fame root puts forth feveral fets or ftems. See PLANT and TREE. Such are privet, phillyrea, holly, box, honey-fuckle, &c. Shrubs and trees put forth in autumn a kind of buttons, or gems, in the axis of the leaves; thefe buttons are as fo many little ova, which, coming to expand by the warmth of the following fpring, open into leaves and flowers. By this, together with the height, fome diftinguifh fhrubs from *fuffrutices*, or under fhrubs, which are low bufhes, that do not put forth any of thefe buttons, as fage, thyme, &c.

The two hardieft fhrubs we are poffeffed of are the ivy and box; thefe ftand the feverity of our fharpeft winters unhurt, while other fhrubs perifh, and trees have their folid bodies fplit and torn to pieces. In the hard winter of the year 1683, thefe two fhrubs fuffered no injury any where; though the yews and hollies, which are generally fuppofed very hardy, were that winter in fome places killed, and in others ftripped of their leaves, and damaged in their bark. Furze-bufhes were found to be fomewhat hardier than thefe, but they fometimes perifhed, at leaft down to the root. The broom feemed to occupy the next ftep of hardinefs beyond thefe. This lived where the others died, and where even this died, the juniper fhrubs were fometimes found unhurt. This laft is the only fhrub that approaches to the hardinefs of the box and ivy, but even it does not quite come up to them; for while they fuffer nothing in whatever manner they are expofed, the juniper, though it bears cold well under the fhelter of other trees, yet cannot bear the viciffitudes of heat and cold; infomuch that fome juniper fhrubs were found half dead and half vigorous; that fide which faced the mid-day fun having perifhed by the fucceffive thawings and freezings of its fap; while that which was not expofed to the viciffitudes of heat had born the cold perfectly well. Such fhrubs as are not hardy enough to defy the winter, but appear half dead in the fpring, may often be recovered by Mr Evelyn's method of beating their branches with a flender hazel-wand, to ftrike off the withered leaves and buds, and give a free paffage to the air to the internal parts. Where this fails, the method is to cut them down to the quick, and if no part of the trunk appears in a growing condition, they muft be taken off down to the level of the ground. Philofophical Tranfactions, N° 165.

SHUTTLE, in the manufactures, an inftrument ufed by the weavers, which guides the thread it contains, either of woollen, filk, flax, or other matter, fo as to make it form the woofs of ftuffs, cloths, linens, ribbands, &c. by throwing the fhuttle alternately from left to right, and from right to left, acrofs between the threads of the warp, which are ftretched out lengthwife on the loom.

In the middle of the fhuttle is a kind of cavity, called the *eye* or *chamber* of the fhuttle; wherein is inclofed the fpoul, which is a part of the thread deftined for the woof; and this is wound on a little tube of paper, rufh, or other matter.

The ribband-weaver's fhuttle is very different from that of moft other weavers, though it ferves for the fame purpofe: it is of box, fix or feven inches long, one broad, and as much deep; fhod with iron at both ends, which terminate in points, and are a little crooked, the one towards the right, and the other towards the left, reprefenting the figure of an ∽ horizontally placed. See WEAVING.

SIALOGOGUES, medicines which promote the falivary difcharge.

1 Boundaries and extent.

SIAM PROPER, by fome called *Upper*, (to diftinguifh it from the *Lower* Siam, under which are often included Laos, Cambodia, and Malacca), is bounded on the north by the kingdoms of Pegu and Laos; on the eaft by Cambodia and Cochin-China; on the fouth by Malacca and the bay of Siam; and on the weft by the ocean. But as the opinions of geographers are extremely various concerning the fituation and extent of moft of the inland countries of Afia and Africa, neither the extent nor boundaries of Siam are yet accurately known. By fome it is fuppofed to extend 550 miles in length, and 250 miles in breadth; in fome places it is not above 50 miles broad.

2 Weather.

The winds blow here from the fouth upon the coaft of Siam, in March, April, and May; in April the rains begin, in May and June they fall almoft without ceafing. In July, Auguft, and September, the winds blow from the weft, and the rains continuing, the rivers overflow their banks nine or ten miles on each fide, and for more than 150 miles up the ftream. At this time, and more particularly in July, the tides are fo ftrong as to come up the river Menan as far as the city of Siam, which is fituated 60 miles from its mouth; and fometimes as far as Louvo, which is 50 miles higher. The winds blow from the weft and north in October, when the rain ceafes. In November and December the winds blow dry from the north, and the waters being in a few days reduced to their ancient channels, the tides become fo infenfible, that the water is frefh at the mouth of the river. At Siam there is never more than one flood and one ebb in the fpace of 24 hours. In January the wind blows from the eaft, and in February from the eaft and fouth. When the wind is at eaft, the

Siam.

the current ſets to the weſt; and, on the contrary, when the wind is at weſt, the currents run to the eaſtward.

As this country is ſituated near the tropic, it muſt neceſſarily be very hot; but yet, as in other places nearly of the ſame latitude, when the ſun is vertical and ſhines with a moſt intenſe heat, the inhabitants are ſo ſkreened by the clouds, and the air is ſo refreſhed by a deluge of rain that overflows the plains which the people chiefly inhabit, that the heat is very ſupportable. The cooleſt wind blows in December and January.

3 Vegetable productions.

The vegetable produce of this country is chiefly rice and wheat, beſides tropical and a few European fruits. The Siameſe prepare the land for tillage as ſoon as the earth is ſufficiently moiſtened by the floods. They plant their rice before the waters riſe to any conſiderable height, and, as they riſe ſlowly, the rice keeps pace with them, and the ear is always above the water. They reap their corn when the water retires, and ſometimes go in boats to cut it while the waters are upon the ground. They alſo ſow rice in ſeveral parts of the kingdom that are not overflowed, and this is thought better taſted, and will keep longer than the other; but they are forced to ſupply theſe fields conſtantly with water, while the rice is growing, from baſins and ponds that lie about them.

They have no European fruits except oranges, lemons, citrons, and pomegranates. They have bananas, Indian figs, jaques, durions, mangoes, mangoſtans, tamarinds, ananas, and cocoa nuts; they have alſo abundance of pepper and ſugar-canes. The mountains are covered with trees which make good maſts. The vegetable of greateſt uſe in the country is the bamboo, which grows chiefly in marſhy ſoils, and is often found of a prodigious ſize. Cotton trees are found in great numbers; and others that yield *capoc*, a very fine cotton wool, but ſo ſhort as to be unfit for ſpinning, though it anſwers very well for ſtuffing mattreſſes and pillows.

4 Animals.

There is no country where elephants abound more than in Siam, or where they are held in greater veneration. They have a few horſes, ſheep, and goats, beſides oxen and buffaloes; but they have no good animal food except the fleſh of hogs, their beef and mutton being of a very indifferent quality.

5 Deſcription of the inhabitants.

The Siameſe are of ſmall ſtature, but well proportioned; their complexions are ſwarthy: the faces of both the men and women are broad, and their foreheads, ſuddenly contracting, terminate in a point, as well as their chins. They have ſmall black eyes, hollow jaws, large mouths, and thick pale lips. Their teeth are dyed black, their noſes are ſhort and round at the end, and they have large ears, which they think very beautiful. Their hair is thick and lank, and both ſexes cut it ſo ſhort that it reaches no lower than their ears; the women make it ſtand up on their foreheads; and the men ſhave their beards.

6 Dreſs.

People of diſtinction wear a piece of calico tied about their loins, that reaches down to their knees.—The men bring up this cloth between their legs, and tuck it into their girdles, which gives it the appearance of a pair of breeches. They have alſo a muſlin ſhirt without a collar, with wide ſleeves, no wriſtbands, and the boſom open. In winter they wear a piece of ſtuff or painted linen over their ſhoulders, like a mantle, and wind it about their arms.

The king of Siam is diſtinguiſhed by wearing a veſt of brocaded ſatin, with ſtraight ſleeves that reach down to the wriſt, under ſuch a ſhirt as we have juſt deſcribed, and it is unlawful for any ſubject to wear this dreſs unleſs he receives it from the king. They wear ſlippers with piked toes turned up, but no ſtockings. The king ſometimes preſents a military veſt to the generals; this is buttoned before, and reaches to the knees; but the ſleeves are wide, and come no lower than the elbows. All the retinue of the king, either in war or in hunting, are clothed in red. The king wears a cap in the form of a ſugar-loaf, encompaſſed by a coronet or circle of precious ſtones, and thoſe of his officers have a circle of gold, ſilver, or of vermilion gilt, to diſtinguiſh their quality; and theſe caps are faſtened with a ſtay under the chin; they are only worn when they are in the king's preſence, or when they preſide in courts of juſtice, and on other extraordinary occaſions. They have alſo hats for travelling; but, in general, few people cover their heads notwithſtanding the ſcorching heat of the ſun.

The women alſo wrap a cloth about their middle, which hangs down to the calf of their legs. They cover their breaſts with another cloth, the ends of which hang over their ſhoulders. But they have no garment correſponding to a ſhift, nor any covering for their heads but their hair. The common people are almoſt naked, and wear neither ſhoes nor ſlippers. The women wear as many rings on the three laſt fingers of each hand as they can keep on, and bracelets upon their wriſts and ancles, with pendants in their ears ſhaped like a pear.

7 Manners and cuſtoms.

For an inferior to ſtand before a ſuperior is deemed inſolent; and therefore ſlaves and people of inferior rank ſit upon their heels, with their heads a little inclined, and their joined hands lifted up to their foreheads. In paſſing by a ſuperior they bend their bodies, joining their hands, and lifting them toward their heads in proportion to the reſpect they would ſhow. When an inferior pays a viſit, he enters the room ſtooping, proſtrates himſelf, and then remains upon his knees, ſitting upon his heels without ſpeaking a word till he is addreſſed by the perſon whom he viſits; for he that is of the higheſt quality muſt always ſpeak firſt. If a perſon of rank viſits an inferior, he walks upright, and the maſter of the houſe receives him at the door, and waits on him ſo far when he goes away, but never farther.

The higheſt part of the houſe is eſteemed the moſt honourable, and no perſon cares to lodge under another's feet. The Siameſe indeed have but one ſtory, but the rooms riſe gradually, and the innermoſt, which are the higheſt, are always the moſt honourable. When the Siameſe ambaſſador came to the French court, ſome of his retinue were lodged in a floor over the ambaſſador's head; but they no ſooner knew it, than they were ſtruck with the greateſt conſternation, and ran down tearing their hair at the thoughts of being guilty of what they conſidered as ſo unpardonable a crime.

The Siameſe never permit ſuch familiarities as are practiſed by gentlemen in Europe. Eaſineſs of acceſs, and

Siam. and affability to inferiors, is in that part of the world thought a ſign of weakneſs, and yet they take no notice of ſome things which would be looked upon as ill breeding among us; ſuch as belching in company, which no man endeavours to prevent, or ſo much as holds his hand before his mouth. They have an extraordinary reſpect for the head, and it is the greateſt affront to ſtroke or touch that of another perſon; nay, their cap muſt not be uſed with too much familiarity; for when a ſervant carries it, it is put on a ſtick and held above his head; and when the maſter ſtands ſtill the ſtick is ſet down, it having a foot to ſtand upon. They alſo ſhow their reſpect by lifting their hands to the head; and therefore, when they receive a letter from any one for whom they have a great reſpect, they immediately hold it up to their heads, and ſometimes lay it upon their heads.

8 Genius and diſpoſitions. They are eſteemed an ingenious people, and though rather indolent than active in diſpoſition, they are not addicted to the voluptuous vices which often accompany a ſtate of eaſe, being remarkably chaſte and temperate, and even holding drunkenneſs in abhorrence.—They are, however, accounted inſolent towards their inferiors, and equally obſequious to thoſe above them; the latter of which qualities appears to be particularly inculcated from their earlieſt youth. In general, their behaviour is extremely modeſt, and they are averſe to loquacity. Like the Chineſe, they avoid ſpeaking in the firſt perſon: and when they addreſs a lady, it is always with ſome reſpectful epithet, inſinuating perſonal accompliſhments.

No man in this country learns any particular trade, but has a general knowledge of all that are commonly practiſed, and every one works ſix months for the king by rotation; at which time, if he ſhould be found perfectly ignorant of the buſineſs he is ſet about, he is doomed to ſuffer the baſtinado. The conſequence of this burdenſome ſervice is, that no man endeavours to excel in his buſineſs, leſt he ſhould be obliged to practiſe it as long as he lives for the benefit of the crown.

9 Government. The government of this country is extremely oppreſſive, the king being not only ſovereign but proprietor of all the lands, and chief merchant likewiſe; by which means he monopolizes almoſt the whole traffic, to the great prejudice of his ſubjects. The crown is ſaid to be hereditary, but it is often transferred by revolutions, on account of the exorbitant abuſe of power in thoſe who exerciſe the royal office. In his palace, the king is attended by women, who not only prepare his food, and wait on him at table, but even perform the part of valets, and put on all his clothes, except his cap, which is conſidered as too ſacred to be touched by any hand but his own. He ſhows himſelf to the people only twice a-year, when he diſtributes his alms to the talapoins or prieſts: and on thoſe occaſions he always appears in an elevated ſituation, or mounted on the back of an elephant. When he takes the diverſion of hunting, he is as uſual attended by his women on foot, preceded by a guard of 200 men, who drive all the people from the roads through which they are to paſs; and when the king ſtops, all his attendants fall upon their faces on the ground.

10 Form of proceſs. All their proceedings in law are committed to writing, and none is ſuffered to exhibit a charge againſt another, without giving ſecurity to proſecute it, and anſwer the damages if he does not prove the fact againſt the perſon accuſed. When a perſon intends to proſecute another, he draws up a petition, in which he ſets forth his complaint, and preſents it to the *nai*, or head of the band to which he belongs, who tranſmits it to the governor; and if the complaint appears frivolous, the proſecutor, according to the laws of the country, ſhould be puniſhed; but the magiſtrates generally encourage proſecutions on account of the perquiſites they bring to their office.

Every thing being prepared for hearing, the parties are ſeveral days called into court, and perſuaded to agree; but this appears to be only a matter of form. At length the governor appoints a day for all parties to attend; and being come into court, the clerk reads the proceſs and opinion of his aſſociates, and then the governor examines upon what reaſons their opinions are founded; which being explained to him, he proceeds to paſs judgement.

11 Trial by ordeal. When ſufficient proofs are wanting, they have recourſe to an ordeal trial, like that of our Saxon anceſtors: both the plaintiff and the defendant walk upon burning coals, and he that eſcapes unhurt is adjudged to be in the right: ſometimes the proof is made by putting their hands in boiling oil; and in both theſe trials, by ſome peculiar management, one or the other is ſaid to remain unhurt. They have alſo a proof by water, in which he who remains longeſt under it is eſteemed innocent. They have another proof, by ſwallowing pills, which their prieſts adminiſter with ſevere imprecations; and the party who keeps them in his ſtomach without vomiting is thought to be innocent.

All theſe trials are made in the preſence of the magiſtrates and people; and the king himſelf frequently directs them to be performed, when crime comes before him by way of appeal. Sometimes he orders both the informer and priſoner to be thrown to the tigers: and the perſon that eſcapes by his not being ſeized upon by thoſe beaſts, is ſufficiently juſtified.

12 Religious opinions. They maintain the doctrine of tranſmigration, believing in a pre-exiſtent ſtate, and that they ſhall paſs into other bodies till they are ſufficiently purified to be received into paradiſe. They believe likewiſe that the ſoul is material, but not ſubject to the touch; that it retains the human figure after quitting a body of that ſpecies; and that when it appears to perſons with whom it was acquainted, which they ſuppoſe it to do, the wounds of one that has been murdered will then be viſible. They are of opinion that no man will be eternally puniſhed; that the good, after ſeveral tranſmigrations, will enjoy perpetual happineſs; but that thoſe who are not reformed will be doomed to tranſmigration to all eternity. They believe in the exiſtence of a Supreme Being; but the objects of their adoration are departed ſaints, whom they conſider as mediators or interceſſors for them; and to the honour of this numerous tribe both temples and images are erected.

13 Marriages. The men of this country are allowed a plurality of women; but excepting one, who is a wife by contract, the others are only concubines, and their children deemed incapable of any legal inheritance. Previous to every nuptial contract, an aſtrologer muſt be conſulted, who calculates the nativity of the parties, and determines whether their union is likely to prove fortunate

Siam || Sibenico.

or otherwife. When his prognoftication is favourable, the lover is permitted to vifit his miftrefs three times, at the laft of which interviews the relations being prefent, the marriage portion is paid, when, without any religious ceremony performed, the nuptials are reckoned complete, and foon after confummated. A few days after the talapoin vifits the married couple, fprinkles them with water, and repeats a prayer for their profperity.

14 Funerals. The practice in Siam refpecting funerals, is both to burn and bury the dead. The corpfe being laid upon the pile, it is fuffered to burn till a confiderable part is confumed, when the remainder is interred in a buryingplace contiguous to fome temple. The reafon which they give for not burning it entirely to afhes is, that they fuppofe the deceafed to be happy when part of his remains efcapes the fire. Inftead of a tombftone, they erect a pyramid over the grave. It was formerly the cuftom to bury treafure with the corpfe; but longer experience evincing, that the facrilegious light in which robbing the graves was confidered did not prevent the crime, they now difcontinue the ancient practice, and inftead of treafure bury only painted papers and other trifles.

15 Rivers. The two principal rivers are the Menan and the Mecon, which rife in the mountains of Tartary, and run to the fouth; the former paffing by the city of Siam, falls into the bay of the fame name, in the 13th degree of north latitude; and the latter running through Laos and Cambodia, difcharges itfelf into the Indian ocean in the 9th degree of north latitude.

6 Defcription of the capital. The capital of the country is Siam, called by the natives *Siyothoya*, fituated in the 101ft degree of eaft longitude, and in the 14th degree of north latitude, being almoft encompaffed by the branches of the river Menan. It is about 10 miles in circumference within the walls, but not a fixth part of the ground is occupied by buildings. In the vacant fpaces there are near 300 pagodas or temples, round which are fcattered the convents of the priefts and their burying-places. The ftreets of the city are fpacious, and fome have canals running through them, over which is a great number of bridges. The houfes ftand on pillars of the bamboo cane, and are built of the fame materials: the communication between different families, during the winter feafon, being carried on as in other tropical countries by means of boats. The grounds belonging to the feveral tenements are feparated by a pallifado, within which the cattle are houfed in barns, erected likewife upon pillars, to preferve them from the annual inundation.

SIBBALDIA, a genus of plants belonging to the clafs of pentandria, and to the order of pentagynia; and in the natural fyftem arranged under the 35th order. *Senticofæ*. See BOTANY *Index*.

SIBENICO, or SEBENICO, the name of a city and province of Dalmatia. The province of Sibenico runs along the fea for more than 30 miles; reaches in fome places above 20 miles within land, and comprehends above 70 iflands. The city of Sibenico is fituated near the mouth of the river Cherca, in the gulf of Venice, 35 miles north of Spalatto, and 25 fouth eaft of Zara. E. Long. 16° 46′. N. Lat. 44° 17′. It belongs to the Venetians. It is defended on one fide by a caftle, which held out againft repeated attacks of the Turks, and towards the fea by a fort.

Siberia.

SIBERIA, a large country, comprehending the moft northerly parts of the Ruffian empire in Afia. It is bounded on the eaft by the eaftern ocean; on the fouth by Great Tartary; on the weft by Ruffia; and on the north by the Frozen ocean. It is about 2000 miles in length from eaft to weft, and 750 miles in breadth from north to fouth. 1 Boundaries and extent.

At what time this country was firft inhabited, or by whom it was peopled, we are entirely ignorant; but writings have been found in it when it was difcovered, which fhows that it muft have been early known to a civilized people *. The Ruffians, from whom we have received our knowledge, knew nothing of it before the middle of the 16th century. In the reign of John Bafilowitz I. indeed, an incurfion had been made into Siberia, and fome Tartar tribes fubdued: but thefe conquefts were not permanent; and we hear of no further communication between Ruffia and Siberia till the time of John Bafilowitz II. It was opened again at that time by means of one Anika Strogonoff, a Ruffian merchant, who had eftablifhed fome falt-works at a town in the government of Archangel. This man carried on a trade with the inhabitants of the north-weft parts of Siberia, who brought every year to the town abovementioned large quantities of the fineft furs. Thus he acquired a very confiderable fortune in a fhort time; when at laft the czar, perceiving the advantages which would accrue to his fubjects from having a regular intercourfe with Siberia, determined to enlarge the communication which was already opened. With this view he fent into Siberia a body of troops, which croffed the Yugorian mountains, that form part of the north-eaftern boundary of Europe. They feem, however, not to have paffed the Irtifh, or to have penetrated farther than the weftern branch of the river Oby. Some Tartar tribes were laid under contribution, and a chief named *Yediger* confented to pay an annual tribute of 1000 fables. But this produced no lafting advantage to Ruffia; for, foon after, Yediger was defeated and taken prifoner by Kutchum Khan, a defcendant of the great Jenghiz Khan: and thus the allegiance of this country to Ruffia was diffolved. 2 Conquered by the Ruffians.

* Bell's Travels.

For fome time we hear of no further attempts made by the Ruffians on Siberia; but in 1577 the foundation of a permanent conqueft was laid by one Yermac Temofeeff, a Coffack of the Don. This man was at firft the head of a party of banditti who infefted the Ruffians in the province of Cafan; but being defeated by the troops of the czar, he retired with 6000 of his followers into the interior parts of that province. Continuing his courfe ftill eaftward, he came to Orel, the moft eafterly of all the Ruffian fettlements. Here he took up his winter-quarters: but his reftlefs genius did not fuffer him to continue for any length of time in a ftate of inactivity; and from the intelligence he procured concerning the fituation of the neighbouring Tartars of Siberia, he turned his arms towards that quarter.

Siberia was at that time partly divided among a number of feparate princes, and partly inhabited by the various tribes of independent Tartars. Of the former Kutchum Khan was the moft powerful fovereign. His dominions confifted of that tract of country which now forms the fouth-weftern part of the province of Tobolfk; and ftretched from the banks of the Irtifh and Oby to 3 State of Siberia at the time of the Ruffian conqueft.

those of the Tobol and Tura. His principal residence was at Sibir, a small fortress upon the river Irtish, not far from the present town of Tobolsk, and of which some ruins are still to be seen. After a course of unremitted fatigue, and a series of victories which almost exceed belief, but of which we have not room to give the detail, our intrepid adventurer dispossessed this prince of his dominions, and seated himself on the throne of Sibir. The number of his followers, however, being greatly reduced, and perceiving he could not depend on the affection of his new subjects, he had recourse to the czar of Muscovy, and made a tender of his new acquisitions to that monarch, upon condition of receiving immediate and effectual support. This proposal was received with the greatest satisfaction by the czar, who granted him a pardon for all former offences, and sent him the required succours. Yermac, however, being soon after drowned in an unsuccessful excursion, the Russians began to lose their footing in the country. But fresh reinforcements being seasonably sent, they not only recovered their ground, but pushed their conquests far and wide; wherever they appeared, the Tartars were either reduced or exterminated. New towns were built, and colonies were planted on all sides. Before a century had well elapsed, all that vast tract of country now called *Siberia*, which stretches from the confines of Europe to the Eastern ocean, and from the Frozen sea to the present frontiers of China, was annexed to the Russian dominions.

4 Climate.

The air of Siberia is, in general, extremely piercing, the cold there being more severe than in any other part of the Russian dominions. The Siberian rivers are frozen very early, and it is late in the spring before the ice is thawed (A). If the corn does not ripen in August, there is little hope of a harvest in this country; and in the

(A) M. Gmelin, M. Muller, and two other philosophers, set out in the year 1733 to explore the dreary regions of Siberia, by desire of the empress Anne of Russia. After spending nine years and a half in observing every thing that was remarkable, they returned to Petersburgh; and an account of this journey was published by M. Gmelin. In order to examine how far the frost had penetrated into the ground, M. Gmelin, on the 18th of June, at a place called Jacutia, ordered the earth to be dug in high ground; they found mould to the depth of 11 inches, under which they met with loose sand to two feet and a half further, after which it grew harder, and at half a foot deeper so hard as scarcely to give way to the tools; so that the ground still remained unthawed at not less than the depth of four feet. He made the same experiment in a lower situation; the soil was 10 inches deep, after that a loose sand for two feet and ten inches, below which all was frozen and hard. At Jacutia the inhabitants preserve in cellars several sorts of berries, which they reckon among their dainties, perfectly good and fresh the whole year, though these cellars are scarcely a fathom deep. At the fortress of Argun, in little more than 50 degrees of latitude, the inhabitants relate that the earth in many places is never thawed above a yard and a half, and that the internal cold of the earth will scarcely permit a well to be dug, of which they bring an instance that happened not long before the author's arrival at that place. They designed to sink a well near a house at some distance from the river Argun, for which purpose they thawed the earth by degrees, and dug some fathoms till they had penetrated a fathom and half below the level of the river, but found no spring. Hence perhaps we may venture to assert, that besides the great elevation of the earth in these countries, there is another cause, perhaps latent in the earth itself, of this extraordinary cold, naturally suggested to us by considering the cavity of an old silver mine at Argun, which being exhausted of its ore, now serves the inhabitants in summer time for a cellar to keep their provisions: this place is so extremely cold as to preserve flesh meats from putrefaction in the hottest summers, and to sink the mercury in De Lisle's thermometer to 146 and 147. The author travelling from Nerschoi towards Argun, to visit the works of the silver mines in that place, August 1735, came to the river Orkija, near Solonischaia, on July the 1st, from whence he arrived a little before dark at the village of Seventua, distant from the river 27 leagues. In this journey he and his fellow travellers for more than four leagues felt it vastly cold; soon after they came into a warm air, which continued some leagues; after which the cold returned; and thus are travellers subjected to perpetual vicissitudes of warmth and cold. But it is observed in general, that the eastern parts are colder than the western, though situated in the same latitude; for as in those eastern regions some tracts of land are much colder than the rest, their effects must be felt by the neighbouring parts. And this conjecture is favoured by the thermometrical observations made with M. de L'Isle's instrument in all parts of Siberia, in which the mercury was depressed to the 226th degree, even in those parts that lie very much towards the south, as in the territory of Selinga, which said degree answers in Fahrenheit's thermometer to about 55.5 below 0, but the same thermometer sometimes indicated a much greater cold. At the fort of Kiringa, on Feb. 10. 1738, at 8 in the morning, the mercury stood at 240. which answers nearly to 72 below 0 in Fahrenheit's. On the 23d of the same month it was a degree lower. At the same place, December 11. at three in the afternoon, it stood at 254 in De Lisle's thermometer, and very near 90 in Fahrenheit's; on December 29. at four in the afternoon, at 263; on November 27. at noon, at 270; January 9. at 275, which several depressions answer in Fahrenheit's to 99.44, 107.73, and 113.65; on January 5. at five in the morning, at 262; an hour after at 281, but at eight o'clock it returned to 250, and there remained till six in the afternoon, and then rose by degrees till an hour before midnight, when it stood at 202. So that the greatest depression of the mercury answers in Fahrenheit's thermometer to 120.76 degrees below 0, which is indeed very surprising, and what nobody ever imagined before. While this cold lasted at Jenisea, the sparrows and magpies fell to the ground, struck dead, as it were, with the frost, but revived if they were soon brought into a warm room. The author was told also that numbers of wild beasts were found in the woods dead and stiff with the frost, and several travellers had their blood and juices quite frozen in their vessels. The air itself at that time was so dismal, that you would think it changed to ice, as it was a thick fog, which was not dissipable by any exhalations, as in the spring and autumn, and the author could scarcely stand three minutes in the porch of his house for the cold.

Siberia. the province of Jeniſeiſk it is ſometimes covered with ſnow before the peaſants can reap it. To defend the inhabitants againſt this extreme ſeverity of the climate, Providence ſeems more liberally to have dealt out to them wood for fuel and furs for clothing. As the winter days in the north parts of Siberia laſt but a few hours, and the ſtorms and flakes of ſnow darken the air ſo much, that the inhabitants, even at noon, cannot ſee to do any thing without artificial lights, they ſleep away the greateſt part of that ſeaſon.

Theſe ſevere winters are rapidly ſucceeded by ſummers, in which the heat is ſo intenſe that the Tunguſians, who live in the province of Jakutſk, go almoſt naked. Here is ſcarcely any night during that ſeaſon; and towards the Frozen ocean the ſun appears continually above the horizon. The vegetables and fruits of the earth are here extremely quick in their growth.

5 Soil and produce. The whole tract of land beyond the 60th degree of north latitude is a barren waſte; for the north part of Siberia yields neither corn nor fruits; though barley is known frequently to come to perfection in Jakutſk.—For this reaſon, the inhabitants of the northern parts are obliged to live on fiſh and fleſh, but the Ruſſians are ſupplied with corn from the ſouthern parts of Siberia, where the ſoil is ſurpriſingly fertile. The countries beyond the lake of Baikal, eſpecially towards the eaſt, as far as the river Argun, are remarkably fruitful and pleaſant; but ſuch is the indolence of the inhabitants, that ſeveral fine tracts of land, which would make ample returns to the peaſant for cultivating them, lie neglected. The paſtures are excellent in this country, which abounds in fine horned cattle, horſes, goats, &c. on which the Tartars chiefly depend for ſubſiſtence. However, there are ſeveral ſteppes, or barren waſtes, and unimprovable tracts in theſe parts; and not a ſingle fruit tree is to be ſeen. There is great variety of vegetables, and in ſeveral places, particularly near Kraſnoia Sloboda, the ground is in a manner overrun with aſparagus of an extraordinary height and delicious flavour. The bulbs of the Turkiſh bundes, and other ſorts of lilies, are much uſed by the Tartars inſtead of bread. This want of fruit and corn is richly compenſated by the great quantities of wild and tame beaſts, and fowls, and the infinite variety of fine fiſh which the country affords (B).

In that part of Siberia which lies near the Icy ſea, as well as in ſeveral other places, are woods of pine, larch, and other trees; beſides which, a conſiderable quantity of wood is thrown aſhore by the waves of the Icy ſea; but whence it comes is not yet aſcertained.

6 Wild beaſts. Beſides the wild fowl with which Siberia abounds, there is a prodigious number of quadrupeds, ſome of which are eatable, and others valuable for their ſkins or furs.

The animals moſt valued for their ſkins are the black fox, the ſable, the hyena, the ermine, the ſquirrel, the beaver, and the lynx. The ſkin of a real black fox is more eſteemed than even that of a ſable. In the country near the Frozen ocean are alſo blue and white foxes. The fineſt ſables come from Nertihinſk and Jakutſk, the inhabitants of which places catch them in the mountains of Stannowoi Krebet. The tributary nations were formerly obliged to pay their taxes in the ſkins of foxes and ſables only. But now the ſkins of ſquirrels, bears, rein-deer, &c. and ſometimes money, are received by way of tribute; and this not only from thoſe who live near the Lena, but alſo in the governments of Ilinſk, Irkutzk, Seleaginſk, and Nertſhinſk. When the Tartars firſt became tributary to Ruſſia, they brought their furs indiſcriminately as they caught them, and among them were often ſables of extraordinary value; and formerly, if any trader brought with him an iron kettle, they gave him in exchange for it as many ſables as it would hold. But they are now better acquainted with their value. They ſell their ſables to ſmugglers at a very high price, and pay only a ruble inſtead of a ſkin to the revenue officers, who now receive more ready money than ſables, by way of tribute. The ſubjects plead the ſcarcity of furs, and indeed not without ſome appearance of truth.

Siberia has ſtill other and more valuable treaſures than thoſe we have yet mentioned. The ſilver mines of Argun are extremely rich; the ſilver they produce yields ſome gold, and both of theſe are found among the copper ore of Koliwan. This country is alſo particularly rich in copper and iron ore. The former lies even upon the ſurface of the earth; and conſiderable mines of it are found in the mountains of Pictow, Koliwan, Ploſkau, Wolkereſenſk, Kuſwi, Alepaik, and ſeveral others, and in the government of Kraſnoiarſk (C). Iron is ſtill more plentiful in all theſe places, and very good; but that of Kamenſki is reckoned the beſt. Several hundred thouſand puds of theſe metals are annually exported from the ſmelting houſes, which belong partly to the crown, and partly to private perſons. Moſt of them lie in the government of Catharinenburg. The Tartars alſo extract a great quantity of iron from the ore. 7 Minerals.

The topazes of Siberia have a fine luſtre; and in open ſandy places, near the river Argun, as well as on the banks of other rivers and lakes, are found ſingle ſmall pieces of agate. Here are alſo carnelians and green jaſper with red veins. The latter is chiefly met with in the deſerts of Gobiſkoi. 8 Precious ſtones.

The famous marienglas, or lapis ſpecularis, great quantities 9 Marienglas.

(B) The oak, though frequent in Ruſſia, it is ſaid, is not to be found through this vaſt region nearer than the banks of the Argun and Amur, in the dominions of China. The white poplar, the aſpen, the black poplar, the common ſallow, and ſeveral ſpecies of the willow, are very common. The Norway and ſilver fir form great foreſts; but the former does not grow beyond the 60th degree of north latitude, and the latter not beyond 58 degrees. To this dreary region of Siberia, Europe is indebted for that excellent ſpecies of oats called *Avena Sibirica;* and our gardens are enlivened with the gay and brilliant flowers brought from the ſame country.

(C) The copper mines of Koliwan, from which gold and ſilver are extracted, employ above 40,000 people. The ſilver mines of Nertſhinſk, beyond Lake Baikal, employ above 14,000. The whole revenue ariſing from theſe mines, according to Mr Coxe, is not leſs than 670,182l. 13s.

Siberia. quantities of which are dug up in Siberia, is by some called Muscovy or Russian glass. It is a particular species of transparent stone, lying in strata like so many sheets of paper. The matrix, or stone in which it is found, is partly a light yellow quartz, or marcassia, and partly a brown indurated fluid; and this stone contains in it all the species of the marienglas. To render the marienglas fit for use, it is split with a thin two-edged knife; but care is taken that the laminæ be not too thin. It is used for windows and lanterns all over Siberia, and indeed in every part of the Russian empire, and looks very beautiful; its lustre and clearness surpassing that of the finest glass, to which it is particularly preferable for windows and lanterns of ships, as it will stand the explosion of cannon. It is found in the greatest plenty near the river Witim.

10 Magnets. Siberia affords magnets of an extraordinary size, and even whole mountains of loadstone. Pit-coal is also dug up in the northern parts of this country. The kamennoe maslo, a yellowish kind of alum, unctuous and smooth to the touch, like tophus, is found in the mountains of Krasnoiarsk, Ural, Altaish, Jenisea, Baikal, Bargusik, Lena, and several others in Siberia.

11 Salt lakes and springs. In this country are not only a great number of fresh water lakes, but likewise several whose waters are salt; and these reciprocally change their nature, the salt sometimes becoming fresh, and the fresh changing into saline. Some lakes also dry up, and others appear where none were ever seen before. The salt lake of Yamusha, in the province of Tobolsk, is the most remarkable of all, for it contains a salt as white as snow, consisting entirely of cubic crystals. One finds also in Siberia saline springs, salt water brooks, and a hill of salt.

12 Curiosities. Siberia affords many other things which deserve notice. That useful root called rhubarb grows in vast quantities near the city of Seleginsk. The curious mammuth's bones and horns, as they are called, which are found along the banks of the Oby, Jenesei, Lena, and Irtish, are unquestionably the teeth and bones of elephants. But whether these elephants teeth and bones were conveyed to these northern regions by the general deluge, or by any other inundation, and were by degrees covered with earth, is a point which might lead us into long and very fruitless disquisitions; we shall therefore only observe, that such bones have likewise been found in Russia, and even in several parts of Germany. A kind of bones of a still larger size than these have also been dug up in Siberia, and seem to have belonged to an animal of the ox kind. The horn of the whale called *narwhal* has been found in the earth near the rivers Indigirka and Anadir; and the teeth of another species of whales, called *wolross*, about Anadirskoi. The latter are larger than the common sort, which are brought from Greenland, Archangel, and Kola.

13 Mountains. The chain of Siberian mountains reaches from that of Werchoturie towards the south as far as the neighbourhood of the city of Orienburg, in a continued ridge, under the name of the Uralian mountains; but from thence it alters its direction westward. These mountains are a kind of boundary between Russia Proper and Siberia. Another chain of hills divides Siberia from the country of the Calmucks and Mongolians.—These mountains, between the rivers Irtish and Oby, are called the Altaic or Golden Mountains, which name they afterwards lose, particularly between the river Jenesei and the Baikal lake, where they are called the Sayanian mountains.

Siberia ‖ Sibyls.

14 Inhabitants. The inhabitants of Siberia consist of the Aborigines or ancient inhabitants, the Tartars, and Russians, computed at 3,500,000.

Some of these nations have no other religion but that of nature; others are Pagans or Mahometans, and some of them have been converted to Christianity, or rather only baptised by the Russian missionaries.

SIBTHORPIA, a genus of plants belonging to the class of didynamia, and to the order of angiospermia; and in the natural system classed with those the order of which is doubtful. See BOTANY *Index*.

SIBYLS, in pagan antiquity, certain women said to have been endowed with a prophetic spirit, and to have delivered oracles, showing the fates and revolutions of kingdoms. Their number is unknown. Plato speaks of one, others of two, Pliny of three, Ælian of four, and Varro of ten; an opinion which is universally adopted by the learned. These ten Sibyls generally resided in the followed places, Persia, Libya, Delphi, Cumæ in Italy, Erythræa, Samos, Cumæ in Æolia, Marpessa on the Hellespont, Ancyra in Phrygia, and Tiburtis. The most celebrated of the Sibyls is that of Cumæ in Italy, whom some have called by the different names of Amalthæa, Demiphile, Herophile, Daphne, Manto, Phemonoe, and Deiphobe. It is said, that Apollo became enamoured of her, and that to make her sensible of his passion he offered to give her whatever she should ask. The Sibyl demanded to live as many years as she had grains of sand in her hand, but unfortunately forgot to ask for the enjoyment of the health, vigour, and bloom, of which she was then in possession. The god granted her request, but she refused to gratify the passion of her lover though he offered her perpetual youth and beauty. Some time after she became old and decrepit, her form decayed, melancholy paleness and haggard looks succeeded to bloom and cheerfulness. She had already lived about 700 years when Æneas came to Italy, and, as some have imagined, she had three centuries more to live before her years were as numerous as the grains of sand which she had in her hand. She gave Æneas instructions how to find his father in the infernal regions, and even conducted him to the entrance of hell. It was usual for the Sibyl to write her prophecies on leaves, which she placed at the entrance of her cave; and it required particular care in such as consulted her to take up these leaves before they were dispersed by the wind, as their meaning then became incomprehensible. According to the most authentic historians of the Roman republic, one of the Sibyls came to the palace of Tarquin the Second, with nine volumes, which she offered to sell for a very high price. The monarch disregarded her, and she immediately disappeared, and soon after returned, when she had burned three of the volumes. She asked the same price for the remaining six books; and when Tarquin refused to buy them, she burned three more, and still persisted in demanding the same sum of money for the three that were left.—This extraordinary behaviour astonished Tarquin; he bought the books, and the Sibyl instantly vanished, and never after appeared to the world. These books were preserved with great care by the monarch, and called the Sibylline verses. A college of priests was appointed to have the care of them; and such reverence did the Romans

Lempriere's Dictionary.

Romans entertain for theſe prophetic books, that they were conſulted with the greateſt ſolemnity, and only when the ſtate ſeemed to be in danger. When the capitol was burnt in the troubles of Sylla, the Sibylline verſes which were depoſited there periſhed in the conflagration; and to repair the loſs which the republic ſeemed to have ſuſtained, commiſſioners were immediately ſent to different parts of Greece to collect whatever verſes could be found of the inſpired writings of the Sibyls. The fate of theſe Sibylline verſes which were collected after the conflagration of the capitol is unknown. There are now many Sibylline verſes extant, but they are reckoned univerſally ſpurious; and it is evident that they were compoſed in the ſecond century by ſome of the followers of Chriſtianity, who wiſhed to convince the heathens of their error, by aſſiſting the cauſe of truth with the arms of pious artifice.

SICERA, a name given to any inebriating liquor by the Helleniſtic Jews. St Chryſoſtom, Theodoret, and Theophilus of Antioch, who were Syrians, and who therefore ought to know the ſignification and nature of "ſicera," aſſure us, that it properly ſignifies palm-wine. Pliny acknowledges, that the wine of the palm tree was very well known through all the eaſt, and that it was made by taking a buſhel of the dates of the palm-tree, and throwing them into three gallons of water; then ſqueezing out the juice, it would intoxicate like wine. The wine of the palm tree is white: when it is drunk new, it has the taſte of the cocoa, and is ſweet as honey. When it is kept longer, it grows ſtrong, and intoxicates. After long keeping, it becomes vinegar.

SICILIAN, in *Muſic*, denotes a kind of gay ſprightly air, or dance, probably invented in Sicily, ſomewhat of the nature of an Engliſh jig; uſually marked with the characters $\frac{6}{8}$, or $\frac{12}{8}$. It conſiſts of two ſtrains; the firſt of four, and the ſecond of eight, bars or meaſures.

1 Boundaries and extent.

SICILY, is a large iſland in the Mediterranean ſea, adjoining to the ſouthern extremity of Italy, and extends from latitude 36° 25′ to latitude 38° 25′, and from longitude 12° 53′ to longitude 16° 5′ eaſt from London. Its greateſt length 210 miles, breadth 133, circumference 600; its form triangular, the three angles being the promontories of Pelorum, Pachynum, and Lilybæum, or as they are now called the Faro, Capo Paſſaro, and Capo Boco. It is divided from Italy by the ſtraits of Meſſina, reaching from the Tower of Faro, which is the moſt northerly part of the iſland, to the *Capo dell' Armi*, or the Cape of Arms, the moſt ſouthern part of Calabria. Theſe ſtraits, by the Latins called *Fretum Siculum*, by the Italians *Il Faro di Meſſina*, and by us the *Faro of Meſſina*, are between 12 and 15 miles over in the broadeſt places, and in the narroweſt about a mile and an half; inſomuch that when Meſſina was taken by the Carthaginians, many of the inhabitants are ſaid to have ſaved themſelves by ſwimming to the oppoſite coaſt of Italy. Hence has ariſen an opinion that the iſland of Sicily was originally joined to the continent, but afterwards ſeparated by an earthquake or ſome other natural cauſe. This ſeparation, however, is reckoned by the moſt judicious among the ancients to be fabulous; and they content themſelves with ſpeaking of it as a thing ſaid to have happened.

2 History during the fabulous ages.

Anciently this iſland was called *Sicania*, *Sicilia*, and *Trinacria* or *Triquetra*; the two former it had from the Sicani and Siculi, who peopled a conſiderable part of the country; the two latter from its triangular figure. Its firſt inhabitants, according to the moſt reſpectable ancient authors, were the Cyclopes and Læſtrigones, who are ſaid to have ſettled in the countries adjoining to Mount Etna; but of their origin we know nothing, except what is related by the poets. After them came the Sicani, who called themſelves the original inhabitants of the country; but ſeveral ancient hiſtorians inform us that they came from a country in Spain watered by the river Siconus. Diodorus, however, is of opinion, that the Sicani were the moſt ancient inhabitants of this iſland. He tells us that they were in poſſeſſion of the whole, and applied themſelves to cultivate and improve the ground in the neighbourhood of Etna, which was the moſt fruitful part of the iſland: they built ſeveral ſmall towns and villages on the hills to ſecure themſelves againſt thieves and robbers; and were governed, not by one prince, but each city and diſtrict by its own king. Thus they lived till Etna began to throw out flames, and forced them to retire to the weſtern parts of the iſland, which they continued to inhabit in the time of Thucydides. Some Trojans, after the deſtruction of their city, landed in the iſland, ſettled among the Sicani, and built the cities of Eryx and Egeſta, uniting themſelves with them, and taking the general name of Elymi or Elymæi. They were afterwards joined by ſome Phocenſes, who ſettled here on their return from the ſiege of Troy.

After the Sicani had for many ages enjoyed an undiſturbed poſſeſſion of the whole of Sicily, or ſuch parts of it as they choſe to inhabit, they were viſited by the Siculi, who were the ancient inhabitants of Auſonia properly ſo called; but being driven out from thence by the Opici, they took refuge in the iſland of Sicily. Not being contented with the narrow bounds allowed them by the Sicani, they began to encroach upon their neighbours; upon which a war enſuing, the Sicani were utterly defeated, and confined to a corner of the iſland, the name of which was now changed from *Sicania* into that of *Sicilia*.

About 300 years after the arrival of the Siculi, the iſland firſt began to be known to the Greeks, who eſtabliſhed various colonies, and built many cities in different parts of the iſland; and it is only from the time of their arrival that we have any hiſtory of the iſland. The firſt of the Greeks that came into Sicily were the Chalcidians of Eubœa, under the conduct of Thucles, who built Naxus, and a famous altar of Apollo, which, as Thucydides tells us, was ſtill ſtanding in his time without the city. The year after, which was, according to Dionyſius Halicarnaſſenſis, the third of the 17th Olympiad, Archias the Corinthian, one of the Heraclidæ, laid the foundations of Syracuſe. Seven years after, a new colony of Chalcidians founded Leontini and Catana, after having driven out the Siculi, who inhabited that tract. About the ſame time Lamis, with a colony from Megara, a city of Achaia, ſettled on the river Pantacius, at a place called *Trotilum*, where his adventurers lived ſome time in common with the Chalcidians of Leontini; but, being driven from thence by the Leontines, he built the city of Thapſus, where he died. Upon his death, the colony left Thapſus; and under the conduct of Hyblon king of the Siculi, founded Megara Hyblæa, where they reſided 245 years, till they

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they were driven out by Gelon tyrant of Syracuse. During their abode at Megara, they sent one Pamilus, who was come from Megara in Achaia, their original city, to build Selinus. This city was founded about 100 years after the foundation of Megara. Antiphemus and Entimus, the former a Rhodian, the other a Cretan, led each a colony of their countrymen, and jointly built the city of Gela on a river of the same name, establishing in their new settlement the Doric customs, about 45 years after the founding of Syracuse. The inhabitants of Gela founded Agrigentum 108 years after their arrival in Sicily, and introduced the same customs there. A few years after, Zancle was built by the pirates of Cumæ in Italy; but chiefly peopled by the Chalcidians, Samians, and Ionians, who chose rather to seek new settlements than live under the Persian yoke. Some time after, Anaxales, tyrant of Rhegium, drove out the ancient proprietors; and, dividing his lands amongst his followers, called the city *Messana* or *Messene*, which was the name of his native city in Peloponnesus. The city of Himera was founded by the Zancleans under the direction of Eucleides, Simus, and Sacon; but peopled by the Chalcidians and some Syracusan exiles, who had been driven out by the contrary faction.

The Syracusans built Acræ, Chasmenæ, and Camarina; the first 70 years, the second 90, and the third 135, after the foundation of their own city. This is the account which Thucydides, a most judicious and exact writer, gives us of the various nations, whether Greeks or Barbarians, who settled in Sicily. Strabo counts among the ancient inhabitants of Sicily the Morgetes, who being driven out of Italy by the Oenotrians, settled in that part of the island where the ancient city of Morgantium stood. The Campani, who assumed the name of *Mamertini*, that is, *invincible warriors*, and the Carthaginians, who settled very early in Sicily, ought likewise to be counted among the ancient inhabitants of the island.

Before this period the history of Sicily is blended with fables like the early history of almost every other country. After the settlement of the Greeks in the island, its various revolutions have been traced from their several sources by many writers; but by none with greater accuracy than Mr Swinburne. From his account of his Travels in the Two Sicilies, we have therefore taken the following concise history of this kingdom, which will at once gratify such of our readers as interest themselves in the fate of a generous people who long struggled in vain for freedom; and at the same time afford them a specimen of the entertainment they may receive from the very elegant work of the author.

Swinburne's *Travels in the Two Sicilies*, vol. i. p. 176.

"Aristocracy prevailed at first in the Greek settlements, but soon made way for tyranny; which in its turn was expelled by democracy. One of the earliest destroyers of common liberty was Phalaris of Agrigentum, who reigned 600 years before Christ: his example was contagious; a legion of tyrants sprung up, and not a commonwealth in the island escaped the lash of an usurper. Syracuse was most oppressed and torn to pieces by dissension; as its wealth and preponderance in the general scale held out a greater temptation than other cities to the ambition of wicked men. It requires the combined testimony of historians to enforce our belief of its wonderful prosperity, and the no less extraordinary tyranny of some of its sovereigns. These Grecian colonies attained to such excellence in arts and sciences as emboldened them frequently to vie with the learned and ingenious in the mother country; nay, often enabled them to bear away the palm of victory: there needs no stronger proof of their literary merits than a bare recital of the names of Archimedes, Theocritus, Gorgias, and Charondas.

3
Grecian colonies in Sicily.

4
Carthaginians conquer great part of it.

"But the Sicilian Greeks were not destined to enjoy the sweets of their situation without molestation. Very soon after their arrival, the inhabitants of the neighbouring coast of Africa began to aspire to a share of Sicily. Carthage sent large bodies of forces at different times to establish their power in the island, and about 500 years before the Christian era had made themselves masters of all the western parts of it. The Siculi retained possession of the midland country, and the southern and eastern coasts were inhabited by the Greeks.

5
Gelo chosen king.

"About that time Gelo was chosen prince of Syracuse on account of his virtues, which grew still more conspicuous after his exaltation: had the example he set been followed by his successors, the advantages of freedom would never have been known or wished for by the Syracusans. The Carthaginians found in him a vigorous opponent to their project of enslaving Sicily, a project invariably pursued but never accomplished.

6
Is succeeded by Hiero.

"Hiero succeeded his brother Gelo, and, contrary to the usual progression, began his reign by a display of bad qualities. Sensible of his error, and improved by experience, he afterwards adopted more equitable measures. At his death the Syracusans threw off the yoke, and for sixty years revelled in all the joys of freedom. Their peace was, however, disturbed by the Athenians and the Carthaginians. The latter plundered Agrigentum, and threatened ruin to the rest of the Grecian states; but a treaty of peace averted that storm. The Athenians, under pretence of supporting their allies the people of Segesta, but in reality from a thirst of dominion, invested Syracuse with a formidable land and naval armament under the command of Nicias; in consequence of a rash indigested plan, ill conducted attacks, and inadequate supplies, their whole host was cut to pieces or led away into captivity.

7
Dionysius the elder and younger.

"Syracuse had scarcely time to breathe after her victory ere intestine wars broke out, and raised Dionysius to supreme command. Avarice, despotism, and cruelty, marked every day of his reign; but his military enterprises were crowned with constant success. He died in peace, and bequeathed a powerful sovereignty to a son of his name tainted with the same and worse vices, but not endowed with equal capacity and martial ability: in such hands the rod of tyranny ceased to be formidable, and the tyrant was driven out of Sicily by the patriotic party; but matters were not sufficiently settled for popular government, and Dionysius resumed the sceptre for a while, till Timoleon forced him into perpetual exile."

8
Agathocles the tyrant.

Liberty seemed now to be established on a permanent basis; but in Syracuse such prospects always proved illusory. Agathocles, a tyrant more inhuman than any preceding usurper, seized the throne, and deluged the country with blood. He was involved in a perilous contest with the Carthaginians, who obtained many advantages

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vantages over him, drove his troops from poſt to poſt, and at laſt blocked up his capital. In this deſperate ſituation, when all foreign helps were precluded, and hardly a reſource remained at home, the genius of Agathocles compaſſed his deliverance by a plan that was imitated among the ancients by Hannibal, and among the moderns by the famous Cortes. He embarked with the flower of his army; forced his way through innumerable obſtacles; landed in Africa; and, having burnt his fleet, routed the Carthaginians in a pitched battle, and laid their territory waſte. Carthage ſeemed to be on the brink of ruin, and that hour might have marked her downfal had the Sicilian hoſt been compoſed of patriotic ſoldiers, and not of ungovernable aſſaſſins; diſcord pervaded the victorious camp, murder and riot enſued; and the tyrant, after beholding his children and friends butchered before his face, eſcaped to Sicily, to meet a death as tragical as his crimes deſerved.

9
Pyrrhus king of Epirus deceives the Sicilians.

Anarchy now raged throughout the iſland, and every faction was reduced to the neceſſity of calling in the aſſiſtance of foreign powers; among whom Pyrrhus king of Epirus took the lead, and reduced all parties to ſome degree of order and obedience. But ambition ſoon prompted him to invade thoſe rights which he came to defend; he caſt off the maſk, and made Sicily feel under his ſway as heavy a hand as that of its former oppreſſors; but the Sicilians ſoon aſſumed courage and ſtrength enough to drive him out of the iſland.

10
The Mamertini ſurpriſe Meſſina, and are aſſiſted by the Romans;

About this period the Mamertini, whom Mr Swinburne indignantly ſtyles a crew of miſcreants, ſurpriſed Meſſina, and, after a general maſſacre of the citizens, eſtabliſhed a republican form of government. Their commonwealth became ſo troubleſome a neighbour to the Greeks, that Hiero II. who had been raiſed to the chief command at Syracuſe in conſideration of his ſuperior wiſdom and warlike talents, found himſelf neceſſitated to form a league with Carthage, in order to deſtroy this neſt of villains. In their diſtreſs the Mamertini implored the aſſiſtance of Rome, though the ſenate had recently puniſhed with exemplary ſeverity one of their own legions for a ſimilar outrage committed at Rhegium. The virtue of the Romans gave way to the temptation, and the deſire of extending their empire beyond the limits of Italy, caſt a veil over every odious circumſtance attending this alliance. A Roman army croſſed the Faro, relieved Meſſina, defeated the Carthaginians, and humbled Hiero into an ally of the republic.

11
which gives riſe to the firſt Punic war.

Thus began the firſt Punic war, which was carried on for many years in Sicily with various ſucceſs. The genius of Hamilcar Barcas ſupported the African cauſe under numberleſs diſappointments, and the repeated overthrows of his colleagues; at laſt, finding his exertions ineffectual, he adviſed the Carthaginian rulers to purchaſe peace at the price of Sicily. Such a treaty was not likely to be obſerved longer than want of ſtrength ſhould curb the animoſity of the vanquiſhed party: when their vigour was recruited, Hannibal ſon of Hamilcar eaſily perſuaded them to reſume the conteſt, and for 16 years waged war in the heart of the Roman territories. Meanwhile Hiero conducted himſelf with ſo much prudence, that he retained the friendſhip of both parties, and preſerved his portion of Sicily in perfect tranquillity. He died in extreme old age, beloved and reſpected both at home and abroad.

12
The ſecond Punic war ... Hannibal.

His grandſon Hieronymus, forſaking this happy line of politics, and contracting an alliance with Carthage, fell an early victim to the troubles which his own folly had excited. Once more, and for the laſt time, the Syracuſans found themſelves in poſſeſſion of their independence: but the times were no longer ſuited to ſuch a ſyſtem; diſſenſions gained head, and diſtracted the public councils. Carthage could not ſupport them, or prevent Marcellus from undertaking the ſiege of Syracuſe, immortalized by the mechanical efforts of Archimedes, and the immenſity of the plunder. See Syracuse.

13
Sicily conquered by the Saracens, and afterwards by the Normans.

The Sicilians after this relinquiſhed all martial ideas, and during a long ſeries of generations turned their attention ſolely to the arts of peace and the labours of agriculture. Their poſition in the centre of the Roman empire preſerved them both from civil and foreign foes, except in two inſtances of a ſervile war. The rapacity of their governors was a more conſtant and inſupportable evil. In this ſtate of apathy and opulence Sicily remained down to the 7th century of our era, when the Saracens began to diſturb its tranquillity. The barbarous nations of the north had before invaded and ravaged its coaſts, but had not long kept poſſeſſion. The Saracens were more fortunate. In 827 they availed themſelves of quarrels among the Sicilians to ſubdue the country. Palermo was choſen for their capital, and the ſtandard of Mahomet triumphed about 200 years. In 1038 George Maniaces was ſent by the Greek emperor with a great army to attack Sicily. He made good his landing, and puſhed his conqueſts with vigour: his ſucceſs aroſe from the valour of ſome Norman troops, which were at that time unemployed and ready to ſell their ſervices to the beſt bidder. Maniaces repaid them with ingratitude; and by his abſurd conduct gave the Muſſelmans time to breathe, and the Normans a pretext and opportunity of invading the Imperial dominions in Italy. Robert and Roger of Hauteville afterwards conquered Sicily on their own account, not as mercenaries; for having ſubſtantially ſettled their power on the continent, they turned their arms againſt this iſland in obedience to the dictates of zeal and ambition. After ten years ſtruggle, the Saracens yielded up the rich prize, and Robert ceded it to his brother Roger, who aſſumed the title of Great Earl of Sicily, ruled the ſtate with wiſdom, and ranks deſervedly among the greateſt characters in hiſtory. He raiſed himſelf from the humble ſtation of a poor younger ſon of a private gentleman, to the exalted dignity of a powerful monarch, by the ſole force of his own genius and courage; he governed a nation of ſtrangers with vigour and juſtice, and tranſmitted his poſſeſſions undiſputed to his poſterity. Such an aſſemblage of great qualities is well intitled to our admiration.

14
Under the dominion of different monarchs.

He was ſucceeded by his ſon Simon, whoſe reign was ſhort, and made way for a ſecond ſon called Roger. In 1127 this prince joined to his Sicilian poſſeſſions the whole inheritance of Robert Guiſcard (ſee Naples, N° 23), and aſſumed the regal ſtyle. The greateſt part of his reign was taken up in quelling revolts in Italy, but Sicily enjoyed profound peace. In 1154 his ſon William aſcended the throne, and paſſed his life in war and confuſion. William II. ſucceeded his father, and died without iſſue. Tancred, though [illegible], was elected his ſucceſſor, and after him his ſon William III. who was [illegible] by Henry of Suabia. [illegible]

the

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the troubles that agitated the reign of his fon the emperor Frederic, peace appears to have been the lot of Sicily. A fhort-lived fedition, and a revolt of the Saracens, are the only commotions of which we read. For greater fecurity, the Saracens were removed to Puglia 400 years after the conqueft of Sicily by their anceftors. Under Conrad and Manfred Sicily remained quiet; and from that time the hiftory of Sicily is related under the article NAPLES, N° 20, &c.

15
Is at length conquered by the Spaniards.

At the death of Charles II. of Spain, his fpoils became an object of furious contention; and at the peace of Utrecht, Sicily was ceded to Victor duke of Savoy, who, not many years after, was forced by the emperor Charles VI. to relinquifh that fine ifland, and take Sardinia as an equivalent. But as the Spaniards had no concern in thefe bargains, they made a fudden attempt to recover Sicily, in which they failed through the vigilance of the Englifh admiral Byng. He deftroyed their fleet in 1718, and compelled them to drop their fcheme for a time. In 1734 the Spanifh court refumed their defign with fuccefs. The infant Don Carlos drove the Germans out, and was crowned king of the two Sicilies at Palermo. When he paffed into Spain to take poffeffion of that crown, he transferred the Sicilian diadem to his fon Ferdinand III. of Sicily, and IV. of Naples, and it has ever fince remained in the poffeffion of the fame family.

16
Account of the ftraits of Meffina.

Sicily is feparated, as we have already obferved, from Italy by a narrow ftrait called the *Faro of Meffina*. This ftrait is ftill remarkable for the rapidity of its currents and the irregular ebbing and flowing of the fea, which fometimes rufhes in with fuch violence as to endanger fhips riding at anchor. Anciently it was much more remarkable for Scylla and Charybdis, the one a rock, and the other a whirlpool, between which it was very dangerous to fteer, and concerning which fo many fables have been related by the ancients. Scylla is a rock on the Italian fide, oppofite to Cape Pylores, which runs out into the fea on the Sicilian fide. Mr Brydone informs us, that the navigation of the ftraits is not even yet performed without danger. He alfo informs us, that the noife of the current which fets through the ftraits may be heard for feveral miles, like the roaring of fome large impetuous river confined between narrow banks. In many places the water rofe into whirlpools and eddies, which are dangerous to fhipping. The current fet exactly for the rock of Scylla, and would certainly have carried any thing thrown into it againft that point. Our author, however, is by no means of opinion that the ftrait is fo dangerous as the ancients have reprefented it; though he thinks that the ftrait is now probably much wider than formerly, which may have diminifhed the danger. There are many fmall rocks, which fhow their heads near the bafe of the large ones. Thefe are probably the dogs defcribed by the ancient poets as howling round Scylla. The rock is near 200 feet high, and has a kind of caftle or fort built on its fummit with a town called *Scylla* or *Sciglio*, containing 300 or 400 inhabitants on its fouth fide, which gives the title of prince to a Calabrefe family.

The following account of thefe rocks and whirlpools is given by the celebrated naturalift Spallanzani. He informs us, that Scylla is a lofty rock, 12 miles from Meffina, rifing almoft perpendicular from the fea on the fhore of Calabria, beyond which is the fmall city of the fame name. Though there was fcarcely any wind, Spallanzani heard, about two miles diftant from the rock, a noife like a confufed barking of dogs, and on a nearer approach he difcovered the caufe. This rock contains a number of caverns, one of the largeft of which is called by the people *Dragara*. The waves, when in the leaft agitated, rufhing into thefe caverns, break, dafh, throw up frothy bubbles, and thus occafion thefe various and multiplied founds. He then perceived with how much truth and refemblance of nature Homer and Virgil, in their perfonifications of Scylla, had pourtrayed this fcene, by defcribing the monfter they drew as lurking in the darknefs of a vaft cavern, furrounded by ravenous barking maftiffs, together with wolves, to increafe the horror.

Though the tide is almoft imperceptible in the open parts of the Mediterranean, it is very ftrong in the ftrait of Meffina, owing to the narrownefs of the channel, and regulated by the periodical elevations and depreffions of the water. Where the current is accompanied by a wind blowing the fame way, veffels have nothing to fear, fince they either do not enter the ftrait, both the wind and ftream oppofing them; or, if both are favourable, enter on full fail, and pafs with fuch rapidity that they feem to fly over the water. When the current runs from fouth to north, and the north wind blows hard at the fame time, the fhip is refifted by the oppofite current, and impelled by two forces in contrary directions, is dafhed on the rock of Scylla, or driven on the neighbouring fands. The current, where it is ftrongeft, does not extend over the whole ftrait, but winds through it in intricate meanders, with the courfe of which the failors ftationed to give ftrangers affiftance are well acquainted, and thus able to guide the fhip in fuch a manner as to avoid it. Should the pilot, however, confiding in his own fkill, neglect fuch affiftance, he would run the moft imminent rifk of being fhipwrecked. In this conflict of the waters, it is ufelefs to throw the line to difcover the depth of the bottom, the violence of the current frequently carrying the lead almoft on the furface of the water. The ftrongeft cables, though fome feet in circumference, break like fmall cords. Every expedient afforded by the art of navigation, is ufelefs here. The only means of avoiding being dafhed againft the rocks, or driven upon the fands in the midft of this perilous conteft of the winds and waves, is to have recourfe to the fkill and courage of the Meffinefe feamen.

Charybdis is diftant from the fhore of Meffina about 750 feet, and is called by the people of the country *Calofaro*, not from the agitation of the waves, but from καλος and φαρος, *beautiful tower*, from the lighthoufe erected near it for the guidance of veffels. When the current fets in from the north, the pilots call it the *defcending rema*, or current; and when it runs from the fouth, the *afcending rema*. The current afcends or defcends at the rifing or fetting of the moon, and continues for fix hours. In the interval between each afcent or defcent, there is a calm which lafts at leaft 15 minutes, but not longer than an hour. Afterwards, at the rifing or fetting of the moon, the current enters from the north, making various angles of incidence with the fhore, and at laft reaches the Calofaro. This delay fometimes continues

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continues two hours; sometimes it immediately falls into the Calofaro; and then experience regards it as a certain indication of bad weather.

When Spallanzani observed Charybdis from the shore, it appeared like a group of tumultuous waters, which group as he approached, became more extensive and more agitated. He was carried to the edge, where he stopped some time to make the requisite observations; and was then convinced beyond the shadow of a doubt, that what he saw was by no means a vortex or whirlpool.

Though he was convinced that there was no gulf under the Calofaro, as otherwise there would have been a whirlpool, which would have carried down into it the floating substances; he determined to sound the bottom with a plummet, and found its greatest depth did not exceed 500 feet. He was also informed, to his great surprise, that beyond the Calofaro, towards the middle of the strait, the depth was double.

When the wind and current are contrary to each other, and both in their greatest violence, the swelling and dashing of the waves within the Calofaro is much stronger, more impetuous, and more extensive. It then contains three or four small whirlpools, or even more, according to the greatness of its extent and violence. If at this time small vessels are driven into the Calofaro by the current or the wind, they are seen to whirl round, rock, and plunge, but are never drawn down into the vortex. They only sink when filled with water, by the waves beating over them. When vessels of a larger size are forced into it, whatever wind they have they cannot extricate themselves; their sails are useless; and after having been for some time tossed about by the waves, if they are not assisted by the pilots of the country, who know how to bring them out of the course of the current, they are furiously driven upon the neighbouring shore of the Lanterna, where they are wrecked, and the greater part of their crews perish in the waves.

If a ship be extricated from the fury of Charybdis, and carried by a strong southerly wind along the strait towards the northern entrance, it will indeed pass out safely; but should it meet with a wind in a nearly opposite direction, it would become the sport of both these winds, and, unable to advance or recede, be driven in a middle course between their two directions, that is to say, full upon the rock of Scylla, if it be not immediately assisted by the pilots. It is likewise observed, that in these hurricanes a land wind frequently rises, which descends from a narrow pass in Calabria, and increases the force with which the ship is impelled towards the rock. Thus, the saying which became proverbial among the ancients;—that "he who endeavours to avoid Charybdis, dashes upon Scylla," is, in a great measure, true.

In the straits, Mr Brydone informs us, a most surprising phenomenon is to be observed. In the heat of summer, after the sea and air have been much agitated, there appears in the heavens over the straits a great variety of singular forms, some at rest and others moving with great velocity. These forms, in proportion as the light increases, seem to become more aerial, till at last, some time before sunrise, they totally disappear. The Sicilians represent this as the most beautiful sight in nature. Leonti, one of the best Sicilian writers, says, that the heavens appear crowded with a variety of objects, such as palaces, woods, gardens, &c. besides the figures of men and other animals that are seen in motion among them. Some treatises have been written concerning this phenomenon; but nothing satisfactory has been delivered concerning its cause.

Sicily.

17 Climate and produce.

Watkin's Travels through Switzerland, Italy, Sicily, &c.

Though Sicily lies in a warm climate, the air is healthful, being refreshed with sea-breezes on every side. It has at all times been remarkably fertile; but the era of its greatest prosperity was from the siege of Syracuse by the Athenians to the Carthaginian conquests. Then and long after it supplied with grain, in years of scarcity, all the countries upon the Mediterranean except Egypt and the coasts of Asia, and Rome and Carthage continually. Even now, under all the impediments of superstition and bad government, its productions are, in quantity and quality, the best in Europe. Of the vegetable are grain, wines, oil, fruits, tobacco, mulberry trees for the silkworm, cotton, medicinal roots, and sugar canes. The last of these flourish near Avola and Merilli. They are of an inferior quality to those of the West Indies, but their sugar is sweeter than any other. The animal production is similar to that of Italy, but the horned cattle are a smaller breed. The coasts abound with fish, particularly with tunney and anchovies; the export of which forms a very lucrative branch of commerce. There are mines of silver, copper, and lead, but none are worked. Near Palma are beds of the best sulphur; at the mouth of the river Giaretta is found a yellow amber, preferable to that of the Baltic: and in every part of the island quarries of marbles, that have furnished materials for all the noble edifices of Sicily. The most beautiful are in the neighbourhood of Palermo, particularly the yellow, and those that resemble the verde antique, porphyry, and lapis lazuli. The population of the island amounts to 1,300,000 souls; not as much again as the single city of Syracuse formerly contained.

18 Rivers and mountains.

Here are several rivers and good springs; but few of the rivers are navigable, having but a short course, and descending precipitately from the mountains. The chief are the Bantera, the Jaretta, and the Salso; of which, the two former run from west to east, and the third from north to south.

Of the mountains in this island the most noted is Mount Etna, now called *Monte Gibello*, or *Mongibello*, a volcano whose eruptions have often proved fatal to the neighbouring country. See ETNA.

19 Constitution and government.

Munter's Memoirs relative to Naples and Sicily.

Were the Sicilians a cultivated people, among whom those arts were encouraged which not only promote the wealth and comfort of a nation, but also exercise the nobler faculties and extend the views of mankind, the circumstances of their government are such, that it might gradually be improved into a free constitution: but to this, the ignorance, superstition, and poverty, of the people seem to be invincible obstacles. The monarchical power in Sicily is far from being absolute; and the parliament claims a share of public authority independently of the will of the king, deduced from a compact made between Roger and the Norman barons after the expulsion of the Saracens. This claim is denied by the king, who wishes the nobles to consider their privileges as derived solely from his favour. Hence the government is in a situation which greatly resembles that of our own and the other kingdoms of Europe in the feudal times; there are continual jealousies and oppositions between the king and the barons, of which an enlightened people might easily take advantage, and obtain that share in the constitution which might secure them

them from future oppression. In these disputes, the king has the advantage at least of power if not of right; and several works, in which the claims of the Sicilian barons have been asserted, were publicly burned not many years ago.

As the sovereign holds his court at Naples, Sicily is governed by a viceroy, who is appointed only for three years, though at the end of that term his commission is sometimes renewed. He lives in great state, and, as the representative of the king, his power is very considerable. He presides in all the courts and departments of government, and is commander in chief of all the forces: he calls or dissolves the parliament when he pleases; and by him all orders, laws, and sentences, must be signed: but his office is far from being desirable, as it generally renders him the object either of the jealousy of the court of Naples, or of the hatred of the Sicilians.

The parliament consists of the nobles, the bishops, and abbots, and the representatives of 43 cities, which are immediately subject to the crown. Those cities which are subject to any of the nobles send no members to the parliament; in these the king has not much authority, and derives little advantage from them. According to the laws, the parliament ought to be assembled at the end of every three years: but the government pays little attention to this rule. The common people are in general very much attached to the nobles, and are inclined to take their part in all their differences with the court: but the magistrates and principal inhabitants of the cities which belong to these feudal lords, wish to get rid of their authority, and imagine that they should be less oppressed, if immediately subject to the king: these inclinations are not disagreeable to the court, and are encouraged by most of the lawyers, who are of great service to government in contesting the privileges of the nobles. Many of these privileges are now abridged; and the power of the barons, with respect to the administration of justice in their domains, was very properly limited by the viceroy Caraccioli, in the year 1785. The government of this nobleman was very beneficial to Sicily, as he, in a great measure, cleared the island of the banditti that used to infest it, and made several excellent regulations for the establishment of social order and personal security. He

20 Inquisition. deserves the thanks of every well-wisher to mankind for having abolished the court of inquisition, which had been established in this country by Ferdinand the Catholic, and made dependent on the authority of the grand inquisitor of Spain. Its last *auto da fe* was held in the year 1724, when two persons were burned. At length Charles III. rendered it independent of the Spanish inquisitor, and abridged its power, by forbidding it to make use of the torture, and to inflict public punishments. The Marchese Squillace, and his successor the Marchese Tanucci, were both enemies to the hierarchy; and, during their viceroyalties, took care to appoint sensible and liberal men to the office of inquisitor: the last of whom was Ventimiglia, a man of a most humane and amiable character, who heartily wished for the abolition of this diabolical court, and readily contributed toward it. While he held the office of inquisitor, he always endeavoured to procure the acquittal of the accused; and when he could succeed no other way, would pretend some informality in the trial. The total annihilation of this instrument of the worst of tyranny was reserved for Caraccioli. A priest being accused to the inquisition, was dragged out of his house and thrown into the dungeon. He was condemned; but, on account of informality, and a violation of justice in the trial, he appealed to the viceroy, who appointed a committee of jurists to examine the process. The inquisitor refused to acknowledge the authority of this commission; pretending that to expose the secrets of the holy office, and to submit its decisions to the examination of lay judges, would be so inconsistent with his duty, that he would see the

21 abolished by Caraccioli. inquisition abolished rather than consent to it. Caraccioli took him at his word, and procured a royal mandate by which the holy office was at once annihilated. He assembled all the nobility, judges, and bishops, on the 27th of March 1782, in the palace of the inquisition, and commanded the king's order to be read; after which he took possession of the archives, and caused all the prisons to be set open: in these were at that time only two prisoners, who had been condemned to perpetual confinement for witchcraft. The papers relating to the finances were preserved; but all the rest were publicly burned. The possessions of the holy office were assigned to the use of churches and charitable institutions: but the officers then belonging to it retained their salaries during their lives. The palace itself is converted into a customhouse, and the place where heretics were formerly roasted alive for the honour of the Catholic faith, is now changed into a public garden. The cognizance of offences against orthodoxy is committed to the bishops: but they cannot cite any one to appear before them without permission from the viceroy; neither can they confine any person to a solitary prison, nor deny him the privilege of writing to his friends, and conversing freely with his advocate. The nobility are so numerous in this island, that Labat says it is paved with noblemen. The general assembly of parliament is composed of 66 archbishops, bishops, abbots, and priors, which form the Bracchio ecclesiastico. Fifty-eight princes, 27 dukes, 37 marquisses, 27 counts, one viscount, and 79 barons, form the militaire; and the demaniale consists of 43 representatives of free towns. Out of each bracchio four deputies are chosen to conduct public business. But the viceroy, the prince of Butera, and the prætor of Palermo, are always the three first. Such was the government of Sicily while the Neapolitan monarchy remained entire; but since the latter was usurped by the French, Sicily is all that is left to its former possessor.

SICINIUS DENTATUS, a tribune of the people, lived a little after the expulsion of the kings from Rome. He was in 120 battles and skirmishes, besides single combats, in all of which he came off conqueror. He served under nine generals, all of whom triumphed by his means. In these battles he received 45 wounds in the forepart of his body, and not one in his back. The senate made him great presents, and he was honoured with the name of the Roman Achilles.

SICYOS, a genus of plants belonging to the class of monœcia, and to the order of syngenesia; and in the natural system arranged under the 34th order, *Cucurbitaceæ*. See BOTANY *Index*.

SIDA, *Yellow* or *Indian MALLOW*, a genus of plants belonging to the class of monadelphia, and to the order of polyandria; and in the natural system ranging under the 37th order, *Columniferæ*. See BOTANY *Index*.

SIDDEE, or SEDEE, an Arabic title, by which the Abyssinians or Habashys are always distinguished in the courts of Hindostan; where, being in great repute for firmness and fidelity, they are generally employed as commanders of forts or in posts of great trust.

SIDEREAL YEAR. See *ASTRONOMY Index*.

SIDERIA, in *Natural History*, the old name of a genus of crystals, used to express those altered in their figure by particles of iron. These are of a rhomboidal figure, and composed only of six planes. Of this genus there are four known species. 1. A colourless, pellucid, and thin one; found in considerable quantities among the iron ores of the forest of Dean in Gloucestershire, and in several other places. 2. A dull, thick, and brown one; not uncommon in the same places with the former. And, 3. A black and very glossy kind, a fossil of great beauty; found in the same place with the others, as also in Leicestershire and Sussex.

SIDERITE, a substance supposed by Meyer to be a new metal; but according to Bergman and Kirwan it is nothing else than a natural combination of phosphoric acid with iron.

SIDERITIS, IRONWORT; a genus of plants belonging to the class of didynamia, and to the order of gymnospermia; and in the natural system ranging under the 42d order *Verticillatæ*. See BOTANY *Index*.

SIDEROXYLON, IRON-WOOD; a genus of plants belonging to the class of pentandria, and to the order of monogynia; and in the natural system ranging under the 53d order, *Dumosæ*. See BOTANY *Index*.

SIDNEY, SIR PHILIP, was born, as is supposed, at Penshurst in Kent in the year 1554: His father was Sir Henry Sidney, an Irish gentleman, and his mother Mary the eldest daughter of John Dudley duke of Northumberland. He was sent when very young to Christchurch college at Oxford, but left the university at 17 to set out on his travels. After visiting France, Germany, Hungary, and Italy, he returned to England in 1575, and was next year sent by Queen Elizabeth as her ambassador to Randolph emperor of Germany. On his return he visited Don John of Austria, governor of the Netherlands, by whom he was received with great respect. In 1579, when Queen Elizabeth seemed on the point of concluding her long projected marriage with the duke of Anjou, Sir Philip wrote her a letter, in which he dissuaded her from the match with unusual elegance of expression, as well as force of reasoning. About this time a quarrel with the earl of Oxford occasioned his withdrawing from court; during which retirement he is supposed to have written his celebrated romance called *Arcadia*.

In 1585, after the queen's treaty with the United States, he was made governor of Flushing and master of the horse. Here he distinguished himself so much both by his courage and conduct, that his reputation rose to the highest pitch. He was named, it is pretended, by the republic of Poland as one of the competitors for that crown, and might even have been elected had it not been for the interference of the queen. But his illustrious career was soon terminated; for in 1586 he was wounded at the battle of Zutphen, and carried to Arnheim, where he soon after died. His body was brought to London, and buried in St Paul's cathedral. He is described by the writers of that age as the most perfect model of an accomplished gentleman that could be formed even by the wanton imagination of poetry or fiction. Virtuous conduct, polite conversation, heroic valour, and elegant erudition, all concurred to render him the ornament and delight of the English court: and as the credit which he enjoyed with the queen and the earl of Leicester was wholly employed in the encouragement of genius and literature, his praises have been transmitted with advantage to posterity. No person was so low as not to become an object of his humanity. After the battle of Zutphen, while he was lying on the field mangled with wounds, a bottle of water was brought him to relieve his thirst; but observing a soldier near him in a like miserable condition, he said, *This man's necessity is still greater than mine;* and resigned to him the bottle of water. Besides his *Arcadia*, he wrote several smaller pieces both in prose and verse, which have been published.

SIDNEY, *Algernon*, was the second son of Robert earl of Leicester, and of Dorothy eldest daughter of the earl of Northumberland. He was born about the year 1617. During the civil wars he took part against the king, and distinguished himself as a colonel in the army of the parliament. He was afterwards appointed one of King Charles's judges, but declined appearing in that court. During the usurpation of Cromwel, Sidney, who was a violent republican, retired to the country, and spent his time in writing those discourses on government which have been so deservedly celebrated. After the death of the Protector, he again took part in the public transactions of his country, and was abroad on an embassy to Denmark when King Charles was restored. Upon this he retired to Hamburgh, and afterwards to Francfort, where he resided till 1677, when he returned to England and obtained from the king a pardon. It has been affirmed, but the story deserves no credit, that during his residence abroad King Charles hired ruffians to assassinate him. After his return he made repeated attempts to procure a seat in parliament, but all of them proved unsuccessful. After the intention of the commons to seclude the duke of York from the throne had been defeated by the sudden dissolution of parliament, Sidney joined with eagerness the councils of Russel, Essex, and Monmouth, who had resolved to oppose the duke's succession by force of arms. Frequent meetings were held at London; while, at the same time, a set of subordinate conspirators, who were not, however, admitted into their confidence, met and embraced the most desperate resolutions. Keiling, one of these men, discovered the whole conspiracy; and Algernon Sidney, together with his noble associates, was immediately thrown into prison, and no art was left unattempted in order to involve them in the guilt of the meaner conspirators.

Howard, an abandoned nobleman, without a single spark of virtue or honour, was the only witness against Sidney; but as the law required two, his discourses on government, found unpublished in his closet, were construed into treason, and declared equivalent to another witness. It was in vain for Sidney to plead that papers were no legal evidence; that it could not be proved they were written by him; and that if they were, they contained nothing treasonable. The defence was overruled; he was declared guilty, condemned, and executed! His attainder was reversed in the first year of King William.

He was a man of extraordinary courage; steady even to obstinacy; of a sincere but rough and boisterous temper. Though he professed his belief in the Christian religion, he was an enemy to an established church, and even, according to Burnet, to every kind of public worship. In his principles he was a zealous republican: government was always his favourite study; and his essays on that subject are a proof of the progress which he made.

SIDON, in *Ancient Geography*, a city of Phœnicia in Asia, famous in Scripture for its riches, arising from the extensive commerce carried on by its inhabitants. Heavy judgements were denounced against the Sidonians on account of their wickedness, which were accomplished in the time of Ochus king of Persia: for that monarch having come against them with an army on account of their rebellion, the city was betrayed by its king; upon which the wretched inhabitants were seized with despair; they set fire to their houses, and 40,000, with their wives and children, perished in the flames.

This city is now called *Saide*, and, according to Mr Bruce's account, not only its harbour is filled up with sand, but the pavement of the ancient city stood $7\frac{1}{2}$ feet lower than the ground on which the present city stands. Volney describes it as an ill-built dirty city. Its length along the sea-shore is about 600 paces, and its breadth 150. At the north-west side of the town is the castle, which is built in the sea itself, 80 paces from the main land, to which it is joined by arches. To the west of this castle is a shoal 15 feet high above the sea, and about 200 paces long. The space between this shoal and the castle forms the road, but vessels are not safe there in bad weather. The shoal, which extends along the town, has a bason inclosed by a decayed pier. This was the ancient port; but it is so choked up by sand, that boats alone can enter its mouth near the castle. Fakr-el-din, emir of the Druses, destroyed all these little ports from Bairout to Acre, by sinking boats and stones to prevent the Turkish ships from entering them. The bason of Saide, if it were emptied, might contain 20 or 25 small vessels. On the side of the sea, the town is absolutely without any wall; and that which encloses it on the land side is no better than a prison-wall. The whole artillery does not exceed six cannons, and these are without carriages and gunners. The garrison scarcely amounts to 100 men. The water comes from the river Aoula, through open canals, from which it is fetched by the women. These canals serve also to water the orchards of mulberry and lemon trees.

Saide is a considerable trading town, and is the chief emporium of Damascus and the interior country. The French, who are the only Europeans to be found there, have a consul, and five or six commercial houses. Their exports consist in silks, and particularly in raw and spun cottons. The manufacture of this cotton is the principal art of the inhabitants, the number of whom may be estimated at about 5000. It is 45 miles west from Damascus. E. Long. 36. 5. N. Lat. 37.

SIDUS GEORGIUM, in *Astronomy*, a new primary planet, discovered by Dr Herschell in the year 1781. By most foreign, and even by some British philosophers, it is known by the name of *Herschell*, in honour of the discoverer. As the other planets are distinguished by marks or characters, the planet Herschell is distinguished by an H, the initial letter of the discoverer's name, and a cross to show that it is a Christian planet. See ASTRONOMY *Index*.

SIEGE, in the art of war, is to surround a fortified place with an army, and approach it by passages made in the ground, so as to be covered against the fire of the place.

SIEGEN, a town of Germany in Wetteravia, with a castle and the title of a principality, which it gives to a branch of the house of Nassau. It is seated on a river of the same name, in E. Long. 8. 5. N. Lat. 50. 53.

SIENNA, a large, ancient, and celebrated city of Tuscany in Italy; capital of the Siennese, with an archbishop's see, a famous university, and a citadel. It is about four miles in circumference, and surrounded with an old wall. The metropolitan church is much esteemed by travellers; and though it is a Gothic structure, the architecture is admirable. It is built with black and white marble, and the pavement is of mosaic work. The town is adorned with a great number of palaces, fountains, and superb churches, as also a magnificent hospital. The great area is round, and the houses about it are of the same height, supported by piazzas, under which people may walk in hot or rainy weather; in the middle is a bason, which can be filled with water at any time, to represent a sea-fight with small vessels. The Italian language is taught here with such purity, that a great many foreigners frequent it on that account. It is seated on three eminences, in a fertile soil, in E. Long. 11. 11. N. Lat. 43. 10.

SIENNESE, a duchy in Italy; bounded on the north by the Florentino, on the south by the Mediterranean sea and the duchy of Castro, on the east by the Perugino and Orvietano, and on the west by the Florentino and the Tuscan sea; being about 55 miles in length, and as much in breadth. The soil is pretty fertile, especially in mulberry trees, which feed a great number of silk-worms; and there are several mineral springs. Sienna is the capital town.

SIERRA LEONA, a large country on the west coast of Africa, which some extend from the Grain Coast on the south-east to Cape Verga or Vega on the north-west, i. e. between 7° and 10° N. Lat. Others, however, confine the country between Cape Verga and Cape Tagrin. There runs through it a great river of the same name, of which the source is unknown, but the mouth is in longitude 12. 30. west, lat. 8. 5. north, and is nine miles wide. The climate and soil of this tract of country appear to be, on both sides of the river, among the best in Africa, or at least the most favourable to European constitutions. The heat is much the same as that of the West Indies; but on the higher grounds there is a cool sea breeze, and in the mountainous parts the air is very temperate. According to Lieutenant Matthew, "Sierra Leona, if properly cleared and cultivated, would be equal in salubrity and superior in produce to any of the islands in the West Indies;" and others have affirmed, that "the air is better for a man's health than in many places of Europe." These advantages of climate induced the English to establish a factory at Sierra Leona; but they chose not the most healthful situation. For the benefit of a spring of good water they fixed their residence in a low valley, which is often overspread with mists and noisome vapours, while the air is clear and serene on the summits of the hills, to which water from the well might be easily carried.

Within the district occupied by this colony are the Foulahs, who are in general of a tawny complexion, though many of them are entirely black. They lead a wandering life, and roam about the country with large droves of cows, sheep, goats, and horses. They are much praised by travellers for their hospitality; nor is their humanity in other respects, less commendable; for, if one of their countrymen have the misfortune to fall into slavery, the rest join stock to redeem him. Elephants are so numerous in the country of the Foulahs, that they are frequently seen in droves of 200 together. The people are very dexterous at hunting them, and other wild beasts; from which they derive their principal articles of trade.

The animal productions of Sierra Leona are lions, from which it has its name; leopards, hyænas, musk cats, and many kinds of weasels; the japanzee or chimpanzee, a species of simia, which has a still more striking resemblance to the human figure than even the ouran outang; porcupines, wild hogs, squirrels, and antelopes. Besides these, which are natives of the country, oxen thrive in it, and even grow fat; asses too are employed in labour, and do not suffer by the climate; but sheep suffer much from the heat, change their wool into hair, grow lean and increase very little; while the hardy goat is here as prolific and large as in any other country. Of the birds which frequent the woods of Sierra Leona we can give no perfect account. A species of crane is mentioned as easily tamed; common poultry multiply fast; ducks thrive well, but geese and turkeys seem not to agree with the climate. Turtles of all kinds are very common, and sometimes of a large size. Crocodiles or alligators of a non-descript species have been found ten or twelve feet in length, and lizards of six different species. Snakes, which are almost innumerable, haunt the houses in the night in search of poultry; and one was observed which measured 18 feet, but was happily found not to be venomous. Fishes are in great variety both in the sea and in the rivers. Besides the whale, the shark, stinging ray, and porpoise, there are eels, horse-mackarel, tarpoons, cavillos, mullets, snappers, yellow-tails, old-maids, ten-pounders, and some other fishes; all of which, except the eels and ten-pounders, are esteemed fine eating. Oysters are found in great abundance, and another shell-fish, which the natives eat. Among the zoophytes, none is more worthy of notice than the common sponge, which covers all the sandy beaches of the river, particularly on the Bullom shore, and would fetch a high price in Great Britain.

Of the numerous vegetable productions of Sierra Leona, our limits will permit us only to mention the following. Rice, which is the plant chiefly cultivated, as the natives subsist almost entirely upon it, grows both in the high and low grounds. It prospers indeed best in swamps, though the grain is better in a drier soil. Next to rice the cassada constitutes the chief food of the inhabitants, and is cultivated with great care. The country likewise produces yams, various kinds of potatoes, eddoes, or the *arum esculentum*. Oil-palm, plantains, and bananas; papaw, guava, oranges and limes; pompions, melons, and cucumbers; pine-apples, pigeon-peas, which dressed like English peas are a good pulse; maize or Indian-corn; millet, cocoa-nut trees; ockra; the tallow-tree; a great variety of tamarinds; different kinds of fig-trees and plums; a kind of fruit resembling grapes, but more acid and acrid; cherries resembling a fine nectarine in taste; a species of the bread fruit-tree; the cream fruit, so called because when wounded it yields a fine white juice resembling sugar or the best milk, of which the natives are very fond; the malaguetta pepper, or grains of paradise; a new species of nutmeg, but whether so good as the common sort has not yet been ascertained; a new species of the Peruvian bark, which it is hoped will prove as useful as the other; and cola, a fruit highly esteemed by the natives for the same virtues with that bark; the ricinus, cassia, dye-stuffs, and gums, of great value; cotton, tobacco, and sugar-canes, which, it is thought, would thrive exceedingly well under proper cultivation.

Considering the ardour of the maritime nations of Europe for settling colonies in distant regions of the globe, it is somewhat surprising that a climate so temperate and a soil so productive as that of Sierra Leona did not long ago attract their notice. But it was left to be colonized for a better purpose than that which first drew the natives of Europe to the West Indies and the American continent. Being thinly inhabited, Sierra Leona appeared to some benevolent gentlemen in England a place where, without incommoding the natives, a sufficient quantity of ground might be bought on which to settle a great number of free negroes, who in 1786 swarmed in London in idleness and want. About 400 of these wretches, together with 60 whites, mostly women of bad character and in ill health, were accordingly sent out, at the charge of government, to Sierra Leona. Necessity, it was hoped, would make them industrious and orderly; and Captain Thomson of the navy, who conducted them, obtained, for their use, a grant of land to his majesty from King Tom, the neighbouring chief, and afterwards from Naimbanna, the king of the country. The colony, however, soon went to ruin; but the land which they occupied, being about 20 miles square, his majesty was enabled to grant by act of parliament to another colony founded on better principles and for a still nobler purpose.

The most intelligent members of that society, which laboured so strenuously to procure an abolition of the slave-trade, justly concluding that the natives of Guinea would reap very little benefit from the attainment of their object, unless they should be taught the principles of religion and the arts of civil life, which alone can render them really free, conceived the plan of a colony at Sierra Leona to be settled for the truly generous purpose of civilizing the Africans by maintaining with them a friendly intercourse, and a commerce in every thing but men. This plan could not be carried into effect but at a very great expence. Subscriptions were therefore opened upon rational and equitable terms, and a sum deemed sufficient was speedily raised. An act of parliament was passed in favour of the subscribers, by which they were incorporated by the denomination of the *Sierra Leona Company*; and in pursuance of that act they held their first meeting at London in October 1791.

The directors having stated the natural advantages of Sierra Leona, and its present miserable condition, observed, that they had not merely to establish a commercial

mercial factory, but that, to introduce civilization, cultivation, and a safe trade, the company must provide for the security of the persons and property of the colonists. The directors therefore resolved, that three or four vessels should sail at once, with such a number of people as would be able to protect and assist each other; with goods both for trade and for the supply of the colony. Accordingly several vessels sailed, having on board a council for the government of the colony and the management of the company's affairs; a number of artificers and other servants of the company; some soldiers, and a very few English settlers. The directors were laudably cautious in the choice of colonists. They admitted into the society no white man of bad character, or who was not a declared enemy to the slave-trade; and as the chief object of their enterprise was the civilization of the natives, it was with great propriety that they chose more than three-fourths of their settlers from the free negroes in Nova Scotia, who had borne arms for the British government during the American war. The superintendant and council were particularly instructed to secure to all blacks and people of colour, at Sierra Leona, equal rights and equal treatment, in all respects, with whites. They were to be tried by jury, as well as others; and the council was desired to allot to the blacks employments suited to their present abilities, and to afford them every opportunity of cultivating their talents. All practicable means of maintaining subordination were directed to be used; and the council was especially instructed to promote religion and morals, by supporting public worship and the due observance of the Sabbath, and by the instruction of the people, and the education of children. But no person was to be prevented from performing or attending religious worship in whatever place, time, or manner, he might think fit, or from peaceably inculcating his own religious opinions. Orders were given in choosing the scite of a town, to consider health as the first object; and the first town was directed to be called *Free-Town*. Articles for building and cultivation were sent out, besides the cargoes for prosecuting the company's commerce; and schools for reading, writing, and accounts, were ordered to be set up for the purpose of instructing the children of such natives as should be willing to put them under the company's care.

The leading object of the company was to substitute, for that disgraceful traffic which has too long subsisted, a fair commerce with Africa, and all the blessings which might be expected to attend it. Considerable advantages appeared hereby likely to result to Great Britain, not only from our obtaining several commodities cheaper, but also for opening a market for British manufactures, to the increasing demands of which it is difficult to assign a limit. From this connection, Africa was likely to derive the still more important benefits of religion, morality, and civilization. To accomplish these purposes, it was necessary for the company to possess a tract of land, as a repository for their goods, and which the Africans might cultivate in peace, secure from the ravages of the slave-trade. It had been ascertained, beyond a doubt, that the climate and soil of Africa were admirably suited to the growth of sugar, spices, coffee, cotton, indigo, rice, and every other species of tropical produce. The company proposed to instruct the natives to raise these articles, and to set them the example, by a spirited cultivation, on its own account. Directions were given to the company's commercial agent to push forward a trade, in a mode prescribed, in the present produce of Africa. Measures were taken for cultivating, on the company's account, the most profitable tropical produce; and in particular, a person of long experience in the West Indies was ordered to begin a sugar plantation. A mineralogist and botanist were likewise engaged to go out and explore the country for new articles of commerce.

Every thing being thus settled upon the most equitable and benevolent principles, the ships sailed with the British colonists, to whom, in March 1792, were added 1131 blacks from Nova Scotia. The native chiefs being reconciled to the plan, and made to understand its beneficent tendency towards their people, the colony proceeded to build *Free-Town*, on a dry and rather elevated spot on the south side of the river. It occupied between 70 and 80 acres, its length being about one-third of a mile, and its breadth nearly the same; and it contained near 400 houses, each having one-twelfth of an acre annexed, on which a few vegetables were raised. There were nine streets running from north-west to south-east, and three cross streets, all 80 feet wide, except one of 160 feet, in the middle of which were all the public buildings. These consisted of a governor's house and offices; a large store-house; a large hospital; six or eight other houses, offices, and shops, occupied by the company's servants; and a church capable of containing 800 people. The colonists at first suffered much from the rainy season, against which it was not in their power to provide sufficient protection; but at the end of it they recovered in a great measure their health and spirits, and proceeded with alacrity to execute the various purposes of their settlement. To excite emulation in culture, the government gave premiums to those colonists who raised the greatest quantities of rice, yams, eddoes, cabbages, Indian corn, and cotton, respectively. To limit the excesses of the slave-trade, and gain the favour of the neighbouring chiefs, the directors instructed the governor and council to redeem any native from the neighbourhood, who should be unjustly sold either to or by a British subject. The servants of the company conducted themselves with the utmost propriety, being sober, moral, and exemplary; and from the labours of the clergymen were derived services highly important in every point of view. Before the end of two years from the institution of the colony, order and industry had begun to show their effects in an increasing prosperity. The woods had been cut down to the distance of about three English miles all round the town. By these means the climate had become healthier, and sickness had diminished. The fame of the colony spread not only along the whole western coast of Africa, but also to parts far distant from the coast; embassies had been received of the most friendly nature from kings and princes several hundred miles distant; and the native chiefs had begun to send their children to the colony, with full confidence, to be taught reading, writing, and accounts, and to be brought up in the Christian religion. In a word, it was not without grounds that the directors looked forward to that joyful period when, by the influence of the company's measures, the continent of Africa should be rescued from her present state of darkness and misery, and exhibit a delightful scene of light

 and

Sierra. and knowledge of civilization and order, of peaceful induſtry and domeſtic comfort. On their beneficent exertions they hoped with confidence for the bleſſing of Providence; they were countenanced and ſupported by the Britiſh government; and upon the breaking out of the preſent war, the French Convention authoriſed one of their agents to write to the directors, requeſting a full account of the deſign of the inſtitution, and the names of the ſhips employed in their ſervice, and aſſuring them of the good wiſhes of the French government to ſo noble an undertaking. How completely that government fulfilled its promiſe is very generally known. Having vindicated the rights of man in Europe by the violation of every principle of truth and juſtice, they determined by the ſame means to give light and liberty to the Africans; and that they have fully carried their determination into effect will be ſeen by the following extract of a letter from Mr Afzelius, the company's botaniſt, dated Sierra Leona, 15th November 1794. "The French have been here and have ruined us. They arrived on the 28th of September laſt, early in the morning, with a fleet conſiſting of one large ſhip, two frigates, two armed brigs, and one cutter, together with two large armed merchant ſhips, taken by them at the Iſles de Loſs, an Engliſh ſlave factory to the north of our colony, and which they have alſo deſtroyed and burnt. So well had they concealed their nation, that we took them at firſt for Engliſh. They had Engliſh-built veſſels, which were rigged in the Engliſh way. They ſhowed the Engliſh flag, and had their ſailors, at leaſt thoſe we ſaw on deck, dreſſed like Engliſh. In ſhort, we did not perceive our miſtake till we obſerved them pointing their guns. We had not ſtrength ſufficient to reſiſt, and therefore our governor gave orders, that as ſoon as they ſhould begin to fire, the Britiſh flag ſhould be ſtruck, and a flag of truce hoiſted. Accordingly this was done, but ſtill they continued firing, and did much damage, both within and without the town. They killed two people and wounded three or four. But as we did not underſtand the meaning of this proceeding, we aſked them for an explanation; and they anſwered us, that we ſhould diſplay the flag of liberty, as a proof of our ſubmiſſion. We aſſured them that it ſhould already have been done, if we had had any, which terminated the hoſtilities from the ſhips. In the mean time, moſt of the inhabitants had fled from the town, having taken with them as much of their property as they conveniently could in ſuch a hurry. I was with the governor, together with a number of others; but as ſoon as I was certain they were enemies, I went towards my own houſe with a view to ſave as much as poſſible of my property and natural collections; but was received in ſuch a manner, that I could not venture to proceed. My houſe was ſituated near the ſhore, and unfortunately juſt oppoſite the frigate which fired. I ſaw the balls paſſing through the houſe, and heard them whizzing about my ears. I ſaw that I ſhould loſe all my property; but life was dearer to me, and I haſtened to the woods.

Wadſtrom, part ii. p. 250.

"In the afternoon the enemy landed, finding the town almoſt deſtitute of people, but rich in proviſions, clothing and other ſtores. They began immediately to break open the houſes and to plunder. What they did not want, they deſtroyed, burnt, or threw into the river. They killed all the cattle and animals they found in the fields or ſtreets, yards or elſewhere, not ſparing even aſſes, dogs, and cats. Theſe proceedings they continued the whole ſucceeding week, till they had entirely ruined our beautiful and proſpering colony; and when they found nothing more worth plundering, they ſet fire to the public buildings and all the houſes belonging to the Europeans; and burnt, as they ſaid, by miſtake nine or ten houſes of the coloniſts. In the mean time, they were not leſs active on the water. They ſent three of their veſſels to Bance iſland, an Engliſh ſlave factory higher up the river, which they plundered and burnt, together with ſome ſlave ſhips lying there. They took beſides about 10 or 12 prizes, including the company's veſſels. Moſt of theſe they unloaded and burnt. They took along with them alſo two of our armed veſſels, one of which was a large ſhip, laden with proviſions, and which had been long expected; but ſhe unfortunately arrived a few days too ſoon, and was taken with her whole cargo. We expected at leaſt to receive our private letters, but even this was refuſed, and they were thrown overboard. At laſt, after inflicting on us every hardſhip we could ſuffer, only ſparing our lives and the houſes of the coloniſts, they ſailed on the 13th of October laſt, at noon, proceeding downwards to the Gold Coaſt, and left us in the moſt dreadful ſituation, without proviſions, medicines, clothes, houſes, or furniture, &c. &c. and I fear much, that moſt of us ſhould have periſhed, had not our friends in the neighbourhood, both natives and Europeans, who were ſo happy as to eſcape the enemy, been ſo kind as to ſend us what they could ſpare. In the mean time, moſt of us have either been, or ſtill are, very ſick, and many have died for want of proper food and medicine. The worſt, however, is now paſt. At leaſt we are not in any want of proviſion, although of the coarſeſt kind, but are deſtitute of the moſt neceſſary articles and utenſils for the houſe, the table, and the kitchen."

It was thus that the Convention executed their purpoſe of *ſpreading light and liberty through the world*. The Sierra Leona colony was eſtabliſhed for no other end than to aboliſh the ſlave-trade, to enlighten the Africans, and to render them virtuous, rational, free, and happy; and thoſe powerful patrons of the rights of man deſtroyed that colony with many circumſtances of the moſt wanton cruelty. Though Mr Afzelius is a Swede, and ought therefore to have been protected by the laws of neutrality, they burnt his houſe with the reſt; deprived him of his trunks, his clothes, and his bed; deſtroyed the natural curioſities which he had collected at the hazard of his life; and carried away the inſtruments by means of which only he could collect more.

In 1798, Free-Town, conſiſted of about 300 houſes, and a number of public buildings, together with three wharfs. The government-houſe, ſo ſituated as to command the town and harbour, was protected by a paliſade, and ſix pieces of cannon. The inhabitants of this colony were then computed at 1200, of whom 15 were ſhopkeepers, 25 fiſhermen, 10 trading ſhipmaſters, owners of ſmall veſſels, 15 ſeamen, 20 labourers employed by the company, 4 ſchoolmaſters; about one half of the whole population petty farmers, and the reſt mechanics. The number of Europeans reſident at that time in the colony

was

was about 30, and nearly 400 free natives wrought as labourers for wages, on the farms in the colony.

A charter of juſtice was obtained in 1800, to controul the turbulence of the blacks from Nova Scotia, and a ſmall military force from Goree was ſtationed at Sierra Leona. Parliament allowed the company 7000l. for the purpoſe of erecting a fort, with a promiſe of 8000l. more for the ſame undertaking. The company alſo received 10,000l. for their expence in ſettling the blacks from Nova Scotia, and a vote of parliament agreed to pay 4000l. for ſupporting the civil government of the colony.

The Maroons arrived in Sierra Leona in the month of October 1800, and greatly aſſiſted in ſuppreſſing an inſurrection of the Nova Scotia blacks, who had attempted to ſeize on the government of the colony. A body of natives of the Timmaney, headed by two of the fugitive blacks, made an attack on the unfiniſhed fort on the 18th of November, about day-break, but they were repulſed with loſs. A truce was concluded; but it was ſuppoſed that the Timmanee chiefs would make uſe of this interval to form alliances with the natives againſt the Britiſh, in order to exterminate them from this part of Africa. Soldiers to the amount of 65 were brought from Goree, and a ſhip of war was ſtationed in the river, to defend the ſettlement.

In 1802, parliament again voted 10,000l. to the company, for the annual expence of the ſettlement; and in February 1803, the directors were informed by Lord Hobart, that it would be for the intereſt of the colony to transfer the civil and military power from the company to the Britiſh government.

When Captain Hallowell arrived at Sierra Leona on the 12th of January 1803, he found the colony in a wretched condition, reporting to government on his return, that the Maroons were not ſatisfied with their condition, regarding it as one in which they could not find ſubſiſtence; that proviſions of every deſcription were both ſcarce and dear; that its inhabitants lived in hourly danger from the natives; and that the whole coloniſts lived in a ſtate of deſpondency. Government, however, was afterwards ſatisfied, from the explanations of the directors and their ſervants, that the account of Captain Hallowell was by much too unfavourable. Expectations are indulged that, ſince the entire abolition of the ſlave-trade, the colony will ſoon obtain a flouriſhing trade with the natives, in the exchange of Britiſh manufactures for the raw produce of the interior parts of Africa.

A committee of the houſe of commons has had a moſt ſatisfactory proof of the progreſſive improvement of the internal adminiſtration of the colony, ariſing from the additional powers conferred on the company by the charter of juſtice, and the increaſed vigilance and exertion of the Company's ſervants. The Maroons have, in a great meaſure, abandoned ſome pernicious habits they had long indulged, and by their attachment to the colony, and peaceable demeanour, have merited the approbation of government. The progreſs made in the erection of works has been conſiderable, and the colony may be regarded in a ſtate of ſufficient ſecurity againſt the attack of any native power. A body of volunteers has been raiſed within the colony, whoſe fidelity and attachment have been tried by experience. The ſickneſs and mortality which for ſome time exiſted, have in a great degree ſubſided; and there is reaſon to believe, that it rather originated with the troops when they entered the colony, and their habits of intemperance, than from any diſorder connected with their reſidence in that ſituation. The number of births, which has for ſome time exceeded that of the deaths in the colony, is a ſatisfactory proof that it is not unfriendly to population.

Sierra Leona is already rendered ſecure againſt the only enemies whoſe hoſtilities it has immediately to apprehend; its reſources are increaſed; its cultivation reviving; and it is in the poſſeſſion of every advantage that can ariſe from the enjoyment of internal tranquillity and order. It is ſufficiently manifeſt, from the inconveniences already experienced in the colony, that during its continuance, it will be eſſentially neceſſary to ſupport a local government capable of maintaining order among its inhabitants, and affording them protection. The expence of the civil eſtabliſhment for ſome years to come cannot be eſtimated at leſs than 10,000l. per annum *; that of completing the propoſed works has been eſtimated at 8000l. It alſo appears that the defence of the colony will require the preſent volunteer force to be permanently kept up, the expence of which has been eſtimated at 4000l. per annum; or if that eſtabliſhment ſhould be diſcontinued, a regular garriſon muſt be maintained at the conſtant eſtabliſhment of 100 effective men, excluſive of about 20 artillery men, which, conſidering the numerous caſualties in that climate, and great expence of ſupporting them, would exceed the ſum already mentioned.

* *The expence of the civil eſtabliſhment for* 1809 *exceeded* 17,000l.

SIERRA MORENA, a conſiderable ridge of mountains of Andaluſia in Spain. See SPAIN.

SIEUR, a title of reſpect among the French, like that of *maſter* among us. It is much uſed by lawyers, as alſo by ſuperiors in their letters to inferiors.

SIFANTO, or SIPHANTO, an iſland of the Archipelago, to the weſt of Paros, to the north-eaſt of Milo, and to the ſouth-weſt of Serphanto. The air is ſo good here, that many of the inhabitants live to the age of 120; and their water, fruits, wild fowl, and poultry, are excellent, but more eſpecially the grapes. It abounds with marble and granite, and is one of the moſt fertile and beſt cultivated of theſe iſlands. The inhabitants employ themſelves in cultivating olive-trees and capers; and they have very good ſilk. They trade in figs, onions, wax, honey, and ſtraw-hats; and may be about 8000 in all. E. Long. 25. 15. N. Lat. 37. 9.

SI-FANS, or TOU-FANS, a people inhabiting the country on the weſt of China. Their country is only a continued ridge of mountains, incloſed by the rivers Hoang-ho on the north, Ya-long on the weſt, and Yang-tſe-kiang on the eaſt, between the 30th and 35th degrees of north latitude.

Groſier's General Deſcription of China, vol. i. p. 203.

The Si-fans are divided into two kinds of people; the one are called by the Chineſe *Black Si-fans*, the other *Yellow;* names which are given them from the different colours of their tents. The black are the moſt clowniſh and wretched; they live in ſmall bodies, and are governed by petty chiefs, who all depend upon a greater.

The yellow Si-fans are ſubject to families, the oldeſt of which becomes a lama, and aſſumes the yellow dreſs. Theſe lama princes, who command in their reſpective diſtricts, have the power of trying cauſes, and puniſhing criminals; but their government is by no means burdenfome; provided certain honours are paid them, and they receive punctually the dues of the god Fo, which amount to very little, they moleft none of their fubjects. The greater part of the Si-fans live in tents; but fome of them have houfes built of earth, and even brick. Their habitations are not contiguous; they form at moft but fome fmall hamlets, confifting of five or fix families. They feed a great number of flocks, and are in no want of any of the neceffaries of life. The principal article of their trade is rhubarb, which their country produces in great abundance. Their horfes are fmall; but they are well fhaped, lively and robuft.

Thefe people are of a proud and independent fpirit, and acknowledge with reluctance the fuperiority of the Chinefe government, to which they have been fubjected: when they are fummoned by the mandarins, they rarely appear; but the government, for political reafons, winks at this contempt, and endeavours to keep thefe intractable fubjects under by mildnefs and moderation: it would, befides, be difficult to employ rigorous means in order to reduce them to perfect obedience; their wild and frightful mountains (the tops of which are always covered with fnow, even in the month of July) would afford them places of fhelter, from which they could never be driven by force.

The cuftoms of thefe mountaineers are totally different from thofe of the Chinefe. It is, for example, an act of great politenefs among them to prefent a white handkerchief of taffety or linen, when they accoft any perfon whom they are defirous of honouring. All their religion confifts in their adoration of the god Fo, to whom they have a fingular attachment; their fuperftitious veneration extends even to his minifters, on whom they have confidered it as their duty to confer fupreme power and the government of the nation.

SIGAULTIAN OPERATION, a method of delivery in cafes of difficult labour, firft practifed by M. Sigault. It confifts in enlarging the dimenfions of the pelvis, in order to procure a fafe paffage to the child without injuring the mother.

SIGESBECKIA, a genus of plants belonging to the clafs of fyngenefia, and to the order of polygamia fuperflua; and in the natural fyftem ranging under the 49th order, *Compofitæ*. See BOTANY *Index*.

SIGETH, a town of Lower Hungary, and capital of a county of the fame name. It is feated in a morafs, and has a triple wall, with ditches full of water; and is defended by a citadel, being one of the ftrongeft places in Hungary. It now belongs to the houfe of Auftria, and was retaken from the Turks in 1669, after it had been blocked up two years. In fome maps it is called *Zigat*. E. Long. 18. 58. N. Lat. 46. 17.

SIGHING, an effort of nature, by which the lungs are put into greater motion, and more dilated, fo that the blood paffes more freely, and in greater quantity, to the left auricle, and thence to the ventricle. Hence we learn, fays Dr Hales, how fighing increafes the force of the blood, and confequently proportionably cheers and relieves nature, when oppreffed by its too flow motion, which is the cafe of thofe who are dejected and fad.

SIGHT, or VISION. See ANATOMY, N° 142. and *Index* fubjoined to OPTICS.

Imperfection of SIGHT with regard to Colours. Under the article COLOURS, is given an inftance of a ftrange deficiency of fight in fome people, who could not diftinguifh between the different colours. In the Phil. Tranf. vol. lxviii. p. 611. we have an account of a gentleman who could not diftinguifh a claret colour from black. Thefe imperfections are totally unaccountable from any thing we yet know concerning the nature of this fenfe.

Second SIGHT. See *SECOND Sight*.

SIGN, in general, the mark or character of fomething abfent or invifible. See CHARACTER.

Among phyficians, the term *fign* denotes fome appearance in the human body which ferves to indicate or point out the condition of the patient with regard to health or difeafe.

SIGN, in *Algebra*. See ALGEBRA.

SIGN, in *Aftronomy*, a conftellation containing a 12th part of the zodiac. See ASTRONOMY *Index*.

NAVAL SIGNALS. When we read at our firefide the account of an engagement, or other interefting operation of an army, our attention is generally fo much engaged by the refults, that we give but little to the movements which led to them, and produced them; and we feldom form to ourfelves any diftinct notion of the conduct of the day. But a profeffional man, or one accuftomed to reflection, and who is not fatisfied with the mere indulgence of eager curiofity, follows every regiment in its movements, endeavours to fee their connection, and the influence which they have had on the fate of the day, and even to form to himfelf a general notion of the whole fcene of action, at its different interefting periods. He looks with the eye of the general, and fees his orders fucceed or fail.

But few trouble themfelves farther about the narration. The movement is ordered; it is performed; and the fortune of the day is determined. Few think how all this is brought about; and when they are told that during the whole of the battle of Cuftrin, Frederic the Great was in the upper room of a country inn, from whence he could view the whole field, while his aids de camp, on horfeback, waited his orders in the yard below, they are ftruck with wonder, and can hardly conceive how it can be done: but, on reflection, they fee the poffibility of the thing. Their imagination accompanies the meffenger from the inn yard to the fcene of action; they hear the general's orders delivered, and they expect its execution.

But when we think for a moment on the fituation of the commander of a fleet, confined on board one fhip, and this fhip as much, or more clofely, engaged, than any other of the fleet; and when we reflect that here are no meffengers ready to carry his orders to fhips of the fquadron at the diftance of miles from him, and to deliver them with precifion and diftinctnefs, and that even if this were poffible by fending fmall fhips or boats, the viciffitudes of wind and weather may render the communication fo tedious that the favourable moment may be irretrievably loft before the order can be conveyed.—When we think of all thefe circumftances, our thoughts are bewildered, and we are ready to imagine that a fea-battle is nothing but the unconnected ftruggle of individual fhips; and that when the admiral has once "cried havoc, and let flip the dogs of war," he

Naval Signals.

1 Signals a language to the eye.

he has done all that his fituation empowers him to do, and he muft leave the fate of the day to the bravery and fkill of his captains and failors.

Yet it is in this fituation, apparently the moft unfavourable, that the orders of the commander can be conveyed, with a difpatch that is not attainable in the operations of a land army. The fcene of action is unincumbered, fo that the eye of the general can behold the whole without interruption. The movements which it is poffible to execute are few, and they are precife. A few words are fufficient to order them, and then the mere fighting the fhips muft always be left to their refpective commanders. This fimplicity in the duty to be performed has enabled us to frame a language fully adequate to the bufinefs in hand, by which a correfpondence can be kept up as far as the eye can fee. This is the language of SIGNALS, a language by writing, addreffed to the eye, and which he that runneth may read. As in common writing certain arbitrary marks are agreed on to exprefs certain founds ufed in fpeech, or rather, as in hieroglyphics certain arbitrary marks are agreed on to exprefs certain thoughts, or the fubjects of thefe thoughts; fo here certain exhibitions are made, which are agreed on to exprefs certain movements to be executed by the commander to whom they are addreffed, and all are enjoined to keep their eyes fixed on the fhip of the conductor of the fleet, that they may learn his will.

2 Ufed in ancient times,

It is fcarcely poffible for any number of fhips to act in concert, without fome fuch mode of communication between the general and the commanders of private fhips. We have no direct information of this circumftance in the naval tactics of the ancient nations, the Greeks and Romans; yet the neceffity of the thing is fo apparent, that we cannot fuppofe it to have been omitted by the moft ingenious and the moft cultivated people who have appeared on the great theatre of the world: and we are perfuaded that Themiftocles, Conon, and other renowned fea commanders of Athens, had fignals by which they directed the movements of their fleets. We read, that when Ægeus fent his fon Thefeus to Crete, it was agreed on, that if the fhip fhould bring the young prince back in fafety, a white flag fhould be difplayed. But thofe on board, in their joy for revifiting their country after their perilous voyage, forgot to hoift the concerted fignal. The anxious father was every day expecting the fhip which fhould bring back his darling fon, and had gone to the fhore to look out for her. He faw her, but without the fignal agreed on. On which the old man threw himfelf into the fea. We find, too, in the hiftory of the Punic wars by Polybius, frequent allufions to fuch a mode of communication; and Ammianus Marcellinus fpeaks of the *fpeculatores* and *vexillarii*, who were on board the fhips in the Adriatic. The coins both of Greece and Rome exhibit both flags and ftreamers. In fhort, we cannot doubt of the ancients having practifed this hieroglyphical language. It is fomewhat furprifing that Lord Dudley, in his *Arcano del Mare*, in which he makes an oftentatious difplay of his knowledge of every thing connected with the fea fervice, makes no exprefs mention of this very effential piece of knowledge, although he muft, by his long refidence in Italy, have known the marine difcipline of the Venetians and Genoefe, the greateft maritime powers then in Europe.

In the naval occurrences of modern Europe, mention is frequently made of fignals. Indeed, as we have already obferved, it feems impoffible for a number of fhips to act in any kind of concert, without fome method of communication. Numberlefs fituations muft occur, when it would be impoffible to convey orders or information by meffengers from one fhip to another, and coaft and alarm fignals had long been practifed by every nation. The idea, therefore, was familiar. We find, in particular, that Queen Elizabeth, on occafion of the expedition to Cadiz, ordered her fecretaries to draw up inftructions, which were to be communicated to the admiral, the general, and the five counfellors of war, and by them to be copied and tranfmitted to the feveral fhips of the navy, not to be opened till they fhould arrive in a certain latitude. It was on this occafion (fays our hiftorian Guthrie,) "that we meet with the firft regular fets of fignals and orders to the commanders of the Englifh fleet." But, till the movements of a fleet have attained fome fort of uniformity, regulated and connected by fome principles of propriety, and agreed on by perfons in the habit of directing a number of fhips, we may with confidence affirm that fignals would be nothing but a parcel of arbitrary marks, appropriated to particular pieces of naval fervice, fuch as attacking the enemy, landing the foldiers, &c.; and that they would be confidered merely as referring to the final refult, but by no means pointing out the mode of execution, or directing the movements which were neceffary for performing it.

3 as well as in modern;

4 but firft formed into a fyftem by James II. when duke of York.

It was James II. when duke of York, who firft confidered this practice as capable of being reduced into a fyftem, and who faw the importance of fuch a compofition. He, as well as the king his brother, had always fhowed a great predilection for the fea fervice; and, when appointed admiral of England, he turned his whole attention to its improvement. He had ftudied the art of war under Turenne, not as a paftime, but as a fcience, and was a favourite pupil of that moft accomplifhed general. Turenne one day pointed him out, faying, "Behold one who will be one of the firft princes and greateft generals of Europe." When admiral of England, he endeavoured to introduce into the maritime fervice all thofe principles of concert and arrangement which made a number of individual regiments and fquadrons compofe a great army. When he commanded in the Dutch war, he found a fleet to be little better than a collection of fhips, on board of each of which the commander and his fhip's company did their beft to annoy the enemy, but with very little dependence on each other, or on the orders of the general: and in the different actions which the Englifh fleet had with the Dutch, every thing was confufion as foon as the battle began. It is remarkable that the famous penfionary De Witt, who from a ftatefman became a navigator and a great fea commander in a few weeks, made the fame reprefentation to the States General on his return from his firft campaign.

In the memoirs of James II. written by himfelf, we have the following paffage: "1665. On the 15th of March, the duke of York went to Gunfleet, the general rendezvous of the fleet, and haftened their equipment. He ordered all the flag officers on board with him every morning, to agree on the order of battle and rank. In former battles, no order was kept, and this

under

under the duke of York, was the firſt in which fighting in a line and regular form of battle was obſerved."

This muſt be conſidered as full authority for giving the duke of York the honour of the invention. For whatever faults may be laid to the charge of this unfortunate prince, his word and honour ſtand unimpeached. And we are anxious to vindicate his claim to it, becauſe our neighbours the French, as uſual, would take the merit of this invention, and of the whole of naval tactics, to themſelves. True it is, that Colbert, the great and juſtly celebrated miniſter of Louis XIV. created a navy for his ambitious and vain-glorious maſter, and gave it a conſtitution which may be a model for other nations to copy. By his encouragement, men of the greateſt ſcientific eminence were engaged to contribute to its improvement: and they gave us the firſt treatiſes of naval evolutions. But it muſt ever be remembered, that our accompliſhed, though miſguided ſovereign, was then reſiding at the court of Louis; that he had formerly acted in concert with the French as a commander and flag officer, and was at this very time aiding them with his knowledge of ſea affairs. In the memorable day at La Hogue, the gallant Ruſſel, obſerving one of Tourville's movements, exclaimed, "There! they have got Pepys * among them." This anecdote we give on the authority of a friend, who heard an old and reſpectable officer (Admiral Clinton) ſay, that he had it from a gentleman who was in the action, and heard the words ſpoken; and we truſt that our readers will not be diſpleaſed at having this matter of general opinion eſtabliſhed on ſome good grounds.

* Pepys was ſecretary to the duke of York.

5 Wonderful ſimplicity of his ſyſtem;

It was on this occaſion, then, that the duke of York made the movements and evolutions of a fleet the object of his particular ſtudy, reduced them to a ſyſtem, and compoſed that "Syſtem of Sailing and Fighting Inſtructions," which has ever ſince been conſidered as the code of diſcipline for the Britiſh navy, and which has been adopted by our rivals and neighbours as the foundation of their naval tactics. It does great honour to its author, although its merit will not appear very eminent to a careleſs ſurveyor, on account of that very ſimplicity which conſtitutes its chief excellence. It is unqueſtionably the reſult of much ſagacious reflection and painful combination of innumerable circumſtances, all of which have their influence; and it is remarkable, that although ſucceeding commanders have improved the ſubject by ſeveral ſubordinate additions, no change has to this day been made in its general principles or maxims of evolution.

Till ſome ſuch code be eſtabliſhed, it is evident that ſignals can be nothing but arbitrary and unconnected hieroglyphics, to be learned by rote, and retained by memory, without any exerciſe of the judgement; and the acquiſition of this branch of nautical ſkill muſt be a more irkſome taſk than that of learning the Chineſe writing. But ſuch a code being once ſettled, the character in which it may be expreſſed becomes a matter of rational diſcuſſion.

Accordingly, the ſailing and fighting inſtructions of the duke of York were accompanied by a ſet of ſignals for directing the chief or moſt frequent movements of the fleet. Theſe alſo were contrived with ſo much judgement, and ſuch attention to diſtinctneſs, ſimplicity, and propriety, that there has hardly been any change found neceſſary; and they are ſtill retained in the Britiſh navy as the uſual ſignals in all caſes when we are not anxious to conceal our movements from an enemy.

6 yet as an art has ſince his time received conſiderable improvements.

Notwithſtanding this acknowledged merit of the duke of York's ſignals, it muſt be admitted that great improvements have been made on this ſubject, conſidered as an art. The art military has, in the courſe of a century paſt, become almoſt an appropriate calling, and has therefore been made the peculiar ſtudy of its profeſſors. Our rivals the French were ſooner, and more formally placed in this ſituation; and the miniſters of Louis XIV. took infinite and moſt judicious pains to make their military men ſuperior to all others by their academical education. A more ſcientific turn was given to their education, and the aſſiſtance of ſcientific men was liberally given them; and all the nations of Europe muſt acknowledge ſome obligations to them for information on every thing connected with the art of war. They have attended very much to this ſubject, have greatly improved it, and have even introduced a new principle into the art; and by this means have reduced it to the moſt ſimple form of reference to the code of ſailing and fighting inſtructions, by making the ſignals immediately expreſſive, not of orders, but of ſimple numbers. Theſe numbers being prefixed to the various articles of the code of inſtructions, the officer who ſees a ſignal thrown out by the admiral reads the number, and reports it to his captain, perhaps without knowing to what it relates. Thus ſimplicity and ſecrecy, with an unlimited power of variation, are combined. We believe that M. de la Bourdonnais, a brave and intelligent officer, during the war 1758, was the author of this ingenious thought.

We do not propoſe to give a ſyſtem of Britiſh ſignals. This would evidently be improper. But we ſhall ſhow our readers the practicability of this curious language, the extent to which it may be carried, and the methods which may be practiſed in accompliſhing this purpoſe. This may make it an object of attention to ſcientific men, who can improve it; and the young officer will not only be able to read the orders of the commander in chief, but will not be at a loſs, ſhould circumſtances place him in a ſituation where he muſt iſſue orders to others.

Signals may be divided into,

I. Day Signals.

II. Night Signals; and,

III. Signals in a Fog.

They muſt alſo be diſtinguiſhed into, 1. Signals of Evolution, addreſſed to the whole Fleet, or to Squadrons of the fleet, or to Divisions of theſe ſquadrons. 2. Signals of Movements to be made by particular ſhips; and, 3. Signals of Service, which may be either general or particular.

7 During an engagement the ſignals of the admiral are repeated by frigates ſtationed out of the line.

The great extent of a large fleet, the ſmoke in time of battle, and the ſituation of the commander in chief, who is commonly in the midſt of the greateſt confuſion and hotteſt fire, frequently makes it very difficult for the officers of diſtant ſhips to perceive his ſignals with diſtinctneſs. Frigates, therefore, are ſtationed out of the line, to windward or to leeward, whoſe ſole office it is to obſerve the admiral's ſignals, and inſtantly to repeat them. The eyes of all the ſignal officers in the private ſhips of war are directed to the repeating frigates, as well as to the admiral; and the officers of the repeating frigate, having no other duty, obſerve the admiral inceſſafely, and, being unembarraſſed by the action, can diſplay the ſignal with deliberation, ſo that it may be very diſtinctly ſeen. Being minutely acquainted with the ſubſtitutions which muſt be made on board the admiral when his maſts and rigging are in diſorder, his (perhaps imperfect) ſignal is exhibited by the repeating frigate in its proper form, ſo as to be eaſily underſtood. And to facilitate this communication, the commanders of the different ſquadrons repeat the ſignals of the commander in chief, and the commanders of diviſion repeat the ſignals of the commanders of their ſquadron.

8 Evolution ſignals are preceded by a ſignal of advertiſement, and accompanied with a directive ſignal.

Every evolution ſignal is preceded by a ſignal of ADVERTISEMENT and PREPARATION, which is general, and frequently by a gun, to call attention; and when all the ſignals have been made which direct the different parts of that evolution, another ſignal is made, which marks the cloſe of the complex ſignal, and divides it from others which may immediately follow it: and as the orders of the commander in chief may relate either to the movements of the whole fleet, thoſe of a ſingle diviſion, or thoſe of certain private ſhips, the EXECUTIVE SIGNAL, which dictates the particular movement, is accompanied by a DIRECTIVE SIGNAL, by which theſe ſhips are pointed out, to which the order is addreſſed.

9 Anſwered by the commander to whom they are addreſſed.

The commander of the ſhip to which any ſignal is addreſſed, is generally required to ſignify by a ſignal (which is general) that he has obſerved it. And if he does not thoroughly underſtand its meaning, he intimates this by another general ſignal. And here it is to be obſerved, that as ſoon as the ſignal is anſwered by the ſhips to which it is addreſſed, it is uſual to haul it down, to avoid the confuſion which might ariſe from others being hoiſted in the ſame place. The order remains till executed, notwithſtanding that the ſignal is hauled down.

10 Annulling ſignal.

It may happen that the commander who throws out the ſignal for any piece of ſervice, ſees reaſons for altering his plan. He intimates this by a general ANNULLING ſignal, accompanying the ſignal already given. This will frequently be more ſimple than to make the ſignals for the movements which would be required for re-eſtabliſhing the ſhips in their former ſituation.

All theſe things are of very eaſy comprehenſion, and require little thought for their contrivance. But when we come to the particular evolutions and movements, and to combine theſe with the circumſtances of ſituation in which the fleet may be at the time, it is evident, that much reflection is neceſſary for framing a body of ſignals which may be eaſily exhibited, diſtinctly perceived, and well underſtood, with little riſk of being miſtaken one for another. We ſhall take notice of the circumſtances which chiefly contribute to give them theſe qualities as we proceed in deſcribing their different claſſes.

I. *Of* DAY SIGNALS.

THESE are made by means of the ſhip's ſails, or by colours of various kinds.

Thoſe made with ſails are but few in number, and are almoſt neceſſarily limited to the ſituation of a fleet at anchor. Thus,

The following Signals	*uſually ſignify*
Main topgallant ſtayſail hoiſted	Officers and men belonging to the ſhip to come on board.
Fore topſail looſe	To prepare for ſailing.
Main topſail looſe	To unmoor.
Main topſail ſheets hauled home	To weigh.
Main topſail ſheets clewed up, and the yard hoiſted	Annul the former ſignal, and the ſhip to come to an anchor.
Topgallant ſails looſe, and the ſheets flying	Diſcovering ſtrange ſails.
Main-topgallant ſail looſe and hoiſted. Topſail-yard down	Recal ſhips in chaſe.
Mizen topſail hoiſted, and the ſheets clewed up	Moor.

Before we proceed to the deſcription of the ſignals by means of colours, ſuch as FLAGS, BANNERS (or triangular flags), PENDANTS OF VANES, we muſt take notice of the oſtenſible diſtinctions of the various diviſions and ſubdiviſions of a fleet, ſo that we may underſtand how the ſame ſignal may be addreſſed to a ſquadron, diviſion, or ſingle ſhip or ſhips. We ſuppoſe it known that a fleet of ſhips of war is diſtributed into three grand diviſions (which we ſhall term *ſquadrons*), called the *van*, *centre*, and *rear*. Theſe denominations have not always a relation to the one being more advanced than the other, either towards the enemy, or in the direction of their courſe.

11 Meaning of the terms van, centre, and rear, in the line of battle at ſea.

In a land army, the poſition of every part is conceived from its reference to the enemy; and the reader, conceiving himſelf as facing the enemy, eaſily underſtands the terms *van*, *centre*, and *rear*, the *right* and *left wing*, &c. But the movements of a ſea army having a neceſſary dependence on the wind, they cannot be comprehended unleſs expreſſed in a language which keeps this circumſtance continually in view. The ſimpleſt and moſt eaſily conceived diſpoſition of a fleet, is that in which it is almoſt indiſpenſably obliged to form in order to engage an enemy. This is a ſtraight line, each ſhip directly ahead of its neighbour, and cloſe hauled. This is therefore called the *line of battle*. In this poſition, the two extremities of the fleet correſpond to the right and left wings of an army. Suppoſe this line to be in the direction eaſt and weſt, the wind blowing from the north-north-weſt, and therefore the fleet on the ſtarboard tack; the ſhips heads are to the weſt, and the weſtermoſt diviſion is undoubtedly the van of the fleet, and the eaſtermoſt diviſion is the rear. And it is in conformity to this arrangement and ſituation that the LIST OF THE FLEET is drawn up. But the ſhips may be on the ſame eaſt and weſt line, cloſe hauled, with their heads to the weſt, but the wind blowing from the ſouth-ſouth-weſt. They muſt therefore be on the larboard tack. The ſame ſhips, and the ſame diviſion, are ſtill, in fact, the van of the fleet. But ſuppoſe the ſhips heads to be to the eaſtward, and that they are cloſe hauled,

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hauled, having the wind from the south-south-east or the north-north-east, the ships which were the real van on both tacks in the former situation are now, in fact, the rear on both tacks; yet they retain the denomination of the *van squadron* of this fleet, and are under the immediate direction of the officer of the second rank, while the other extremity is under the direction of the third officer. This subordination therefore is rather an arrangement of rank and precedence than of evolution. It is, however, considered as the NATURAL ORDER to which the general signals must be accommodated. For this reason, the division which is denominated *van* in the list of this fleet, is *generally* made to lead the fleet when in the line of battle on the starboard tack, and to form the *weathermost* column in *the order of sailing in columns;* and, in general, it occupies that station from which it can most easily pass into the place of the leading division on the starboard line of battle ahead. Although this is a technical nicety of language, and may frequently puzzle a landsman in reading an account of naval operations, the reflecting and intelligent reader will see the propriety of retaining this mode of conceiving the subordinate arrangement of a fleet, and will comprehend the employment of the signals which are necessary for re-establishing this arrangement, or directing the movements while another arrangement is retained.

12 How signals are addressed to each of these divisions.

This being understood, it is easy to contrive various methods of distinguishing every ship by the place which she occupies in the fleet, both with respect to the whole line, with respect to the particular squadron, the particular division of that squadron, and the particular place in that division. This may be done by a combination of the position and colour of the pendants and vanes of each ship. Thus the colour of the pendants may indicate the squadron, their position or mast on which they are hoisted may mark the division of that squadron, and a distinguishing vane may mark the place of the private ship in her own division. The advantages attending this method are many. In a large fleet it would hardly be possible for the commander in chief to find a sufficient variety of single signals to mark the ship to which an order is addressed, by hoisting it along with the signal appropriated to the intended movement. But by this contrivance one-third part of these signals of address is sufficient. It also enables the commander in chief to order a general change of position by a single signal, which otherwise would require several. Thus, suppose that the fore, main, and mizen masts, are appropriated (with the proper modifications) for exhibiting the signals addressed to the van, the centre, and the rear squadrons of the fleet, and that a red, a white, and a blue flag, are chosen for the distinguishing flags of the officers commanding these squadrons; then, if the commander in chief shall hoist a red flag at his mizen topgallant mast head, it must direct the van squadron to take the position then occupied by the rear squadron, the evolution necessary for accomplishing this end being supposed known by the commander of the squadron, who will immediately make the necessary signals to the squadron under his particular direction. In the same manner, the distinguishing signal for the leading ship of a squadron being hoisted along with the signal of address to the whole fleet, and the signal for any particular service, will cause the three or the nine leading ships to execute that order, &c. &c.

All that has been said hitherto may be considered as so many preparations for the real issuing of orders by the commander in chief. The most difficult part of the language remains, viz. to invent a number of signals which shall correspond to that almost infinite variety of movements and services which must be performed.

13 Essential qualities of signals are distinctness,

Distinctness, simplicity, and propriety, are the three essential qualities of all signals. A signal must be some object easily seen, strongly marked, so that it may be readily understood, with little risk of its being mistaken for another. When made by flags, banners, or pendants, they must be of the fullest colours, and strongest contrasts. The ships are frequently at a very great distance, so that the intervening air occasions a great degradation of colour. They are seen between the eye and a very variable sky; and in this situation, especially in the morning or evening, or a dark day, it is not easy to distinguish one full colour from another, all of them approaching to the appearance of a black. At the distance of a very few miles hardly any full colours can be distinguished but a scarlet and a blue. Red, blue, yellow, and white, are the colours which can be distinguished at greater distances than any others, and are therefore the only colours admitted as signals. Even these are sometimes distinguished with difficulty. A yellow is often confounded with a dirty white, and a blue with a red. All other dark colours are found totally unfit. But as these afford but a small variety, we must combine them in one flag, by making it striped, spotted, or chequered, taking care that the opposition of colour may be as great as possible, and that the pieces of which the flags are made up may not be too minute. Red must never be striped nor spotted with blue; and the stripes, spots, or chequers, should never be less than one-third of the breadth of the flag. Plate CCCCXCVI is a selection by an officer of experience as a set very easily recognised, and little liable to be confounded. Their colours are represented by hatching, in the same manner as in heraldry (see HERALDRY).

Difference of shape, as flags, banners, or pendants, is another distinction by which the expression may be varied. And in doing this, we must recollect, that in light winds it may be difficult to distinguish a flag from a banner, as neither are fully displayed for want of wind to detach the fly from the staff.

And, lastly, signals may be varied by their position, which may be on any lofty and well detached part of the masts, yards, or rigging.

14 simplicity,

Simplicity is an eminent property in all signals. They are addressed to persons not much accustomed to combinations, and who are probably much occupied by other pressing duties. It were to be wished that every piece of service could be indicated by a single flag. This is peculiarly desirable with respect to the signals used in time of battle. The rapid succession of events on this occasion call for a multitude of orders from the commander in chief, and his ship is frequently clad over with flags and pendants, so that it is exceedingly difficult for the signal officer of a private ship to distinguish the different groups, each of which make a particular signal.

These

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15 and propriety.

These considerations are the foundation of a certain *propriety* in signals, which directs us to a choice among marks which appear altogether arbitrary. Signals which run any risk of being confounded, on account of some resemblance, or because their position hinders us from immediately perceiving their difference, should be appropriated to pieces of service which are hardly possible to be executed, or can hardly be wanted, in the same situation. No bad consequence could easily result though the signal for *coming to closer action* should resemble that for *unmooring*, because the present situation of the ships makes the last operation impossible or absurd. Such considerations direct us to select for battle signals, those which are of easiest exhibition, are the most simple, and have the least dependence on the circumstance of position; so that their signification may not be affected by the damages sustained in the masts or rigging of the flag ship. Such signals as are less easily seen at a distance, should be appropriated to orders which can occur only in the middle of the fleet, &c. &c. Signals which are made to the admiral by private ships may be the same with signals of command from the flag ship, which will considerably diminish the number of signals perfectly different from each other.

16 By what means signals are distinctly conveyed,

With all these attentions and precautions a system of signals is at last made up, fitted to the code of sailing and fighting instructions. It is accompanied by another small set for the duty of convoys. It must be engrossed in two books; one for the officer of the flag ship, who is to make the signals, and the other is delivered to every private ship. In the first, the evolutions, movements, and other operations of service, are set down in one column, and their corresponding signals in another. The first column is arranged, either alphabetically, by the distinguishing phrase, or systematically, according to the arrangement of the sailing and fighting instructions. The officer whose duty it is to make the signals, turns to this column for the order which he is to communicate, and in the other column he finds the appropriated signal.

17 and understood.

In the other book, which is consulted for the interpretation of the signals, they are arranged in the leading column, either by the flags, or by the places of their exhibition. The first is the best method, because the derangement of the flag ship's masts and rigging in time of action may occasion a change in the place of the signal.

18 The art of signals much improved since the publication of the *Tactique Navale*.

The *Tactique Navale* of the Chevalier de Morogues contains a very full and elaborate treatise on signals. We recommend this work to every sea-officer, as full of instruction. The art of signals has been greatly simplified since the publication of this work, but we cannot but ascribe much of the improvements to it. We believe that the author is the inventor of that systematic manner of addressing the order or *effective signal* to the different squadrons and divisions of the fleet, by which the art of signals is made more concise, the execution of orders is rendered more systematic, and the commanders of private ships are accustomed to consider themselves as parts of an army, with a mutual dependence and connection. We are ready enough to acknowledge the superiority of the French in manœuvring, but we affect to consider this as an imputation on their courage. Nothing can be more unjust; and dear-bought experience should long ere now have taught us the value of this superiority. What avails that courage which we would willingly arrogate to ourselves, if we cannot come to action with our enemy, or must do it in a situation in which it is almost impossible to succeed, and which needlessly throws away the lives of our gallant crews? Yet this must happen, if our admirals do not make evolutions their careful study, and our captains do not habituate themselves, from their first hoisting a pendant, to consider their own ship as connected with the most remote ship in the line. We cannot think that this view of their situation would in the least lessen the character which they have so justly acquired, of fighting their ship with a courage and firmness unequalled by those of any other nation. And we may add, that it is only by such a rational study of their profession, that the gentleman can be distinguished from the mercenary commander of a privateer.

II. Night Signals.

It is evident, that the communication of orders by night must be more difficult and more imperfect than by day. We must, in general, content ourselves with such orders as are necessary for keeping the fleet together, by directing the more general movements and evolutions which any change of circumstances may render necessary. And here the division and subordinate arrangement of the fleet is of indispensable necessity, it being hardly possible to particularise every ship by a signal of address, or to see her situation. The orders are therefore addressed to the commanders of the different divisions, each of whom is distinguished by his poop and top-lights, and is in the midst of, and not very remote from, the ships under his more particular charge. Yet even in this unfavourable situation, it is frequently necessary to order the movements of particular ships. Actions during the night are not uncommon. Pursuits and rallyings are still oftener carried on at this time. The common dangers of the sea are as frequent and more disastrous. The system of signals therefore is very incomplete till this part be accomplished.

Night signals must be made by guns, or by lights, or by both combined.

19 How gun-signals may be varied.

Gun-signals are susceptible of variety both in number and in disposition. The only distinct variation which can be made in this disposition, is by means of the time elapsed between the discharges. This will easily admit of three varieties, slow, moderate, and quick.—Half-minute guns are as slow as can easily be listened to as appertaining to one signal. Quarter-minute guns are much better, and admit of two very distinct subdivisions. When the gunners, therefore, are well trained to this service (especially since the employment of firelocks for cannon), intervals of 15 or 12 seconds may be taken for slow firing, 8 or 10 seconds for moderate, and 4 or 5 seconds for quick firing. If these could be reduced one half, and made with certainty and precision, the expression would be incomparably more distinct. A very small number of firings varied in this way will give a considerable number of signals. Thus five guns, with the variety of only quick and moderate, will give 20 very distinguishable signals. The same principle must be attended to here as in the flag signals. The most simple must be appropriated to the most important orders, such as occur in the worst weather, or such as are most

moſt liable to be miſtaken. Quick firing ſhould not make part of a ſignal to a very diſtant ſhip, becauſe the noiſe of a gun at a great diſtance is a lengthened ſound, and two of them, with a very ſhort interval, are apt to coaleſce into one long-continued ſound. This mode of varying gun-ſignals by the time muſt therefore be employed with great caution, and we muſt be very certain of the ſteady performance of the gunners.

Note, that a preparatory ſignal or advertiſement that an effective ſignal is to be made, is a very neceſſary circumſtance. It is uſual (at leaſt in hard weather) to make this by a double diſcharge, with an interval of half a ſecond, or at moſt a ſecond.

Gun-ſignals are ſeldom made alone, except in ordinary ſituations and moderate weather; becauſe accident may derange them, and inattention may cauſe them to eſcape notice, and, once made, they are over, and their repetition would change their meaning. They are alſo improper on an enemy's coaſt, or where an enemy's cruiſers or fleets may be expected.

20 Signals by lights.

Signals by lights are either made with LIGHTS ſimply ſo called, i. e. lanthorns ſhown in different parts of the ſhip, or by rockets. Lights may differ by number, and by poſition, and alſo by figure. For the flag ſhip always carrying poop or top-lights, or both, preſents an object in the darkeſt night, ſo that we can tell whether the additional lights are exhibited about the mainmaſt, the foremaſt, the mizenmaſt, &c. And if the lights ſhown from any of theſe ſituations are arranged in certain diſtinguiſhable ſituations in reſpect to each other, the number of ſignals may be greatly increaſed. Thus three lights may be in a vertical line, or in a horizontal line, or in a triangle; and the point of this triangle may be up, or down, or forward, or aft, and thus may have many ſignifications.

Lights are alſo exhibited by falſe fires or rockets: Theſe can be varied by number, and by ſuch differences of appearance as to make them very diſtinguiſhable. Rockets may be with ſtars, with rain fire, or ſimple ſquibs.

21 Theſe two ſpecies of ſignals may be combined.

By varying and combining theſe, a very great number of ſignals may be produced, fully ſufficient to direct every general movement or evolution, or any ordinary and important ſervice. The Chevalier de Morogues has given a ſpecimen of ſuch a ſyſtem of night ſignals, into which he has even introduced ſignals of addreſs or direction to every ſhip of a large fleet; and has alſo given ſignals of number, by which depths of ſoundings, points of the compaſs, and other things of this kind, may be expreſſed both eaſily and diſtinctly. He has made the ſignals by rockets perfectly ſimilar in point of number to thoſe by lanthorns, ſo that the commander can take either; a choice which may have its uſe, becauſe the ſignals by rockets may cauſe the preſence of a fleet to be more extenſively known than may be convenient.

22 General obſervations concerning night ſignals.

The commander in chief will inform the fleet by ſignal, that guns, or perhaps rockets, are not to be uſed that night. This ſignal, at the ſame time, directs the fleet to cloſe the line or columns, that the light ſignals may be better obſerved.

It is indeed a general rule to ſhow as few lights as poſſible; and the commander frequently puts out his own poop and top lights, only ſhowing them from time to time, that his ſhips may keep around him.

The ſignal lanthorns on board the flag ſhip, and a lanthorn kept in readineſs on board of every private ſhip, to anſwer or acknowledge ſignals from the commander in chief, are all kept in bags, to conceal their lights till the moment they are fixed in their places, and the preparatory or advertiſing ſignal has been made.

The commander in chief ſometimes orders by ſignal every ſhip to ſhow a light for a minute or two, that he may judge of the poſition of the fleet; and the admiral's ſignal muſt always be acknowledged by thoſe to whom it is addreſſed.

It is of particular importance that the fleet be kept together. Therefore the leading ſhips of the fleet, on either tack, are enjoined to acknowledge the ſignals of the commander in chief by a ſignal peculiar to their ſtation. Thus the commander in chief learns the poſition of the extremities of his fleet.

In framing a ſet of night ſignals, great attention muſt be given to their poſition, that they be not obſcured by the ſails. The nature of the order to be given will frequently determine this. Thus, an order for the rear ſhips to make more ſail, will naturally direct us to exhibit the ſignal at the mizen peek; and ſo of other pieces of ſervice. Lanthorns expoſed in groups, ſuch as triangles, lozenges, &c. are commonly ſuſpended at the corners of large frames of laths, at the diſtance of a fathom at leaſt from each other. Attempts have been made to ſhow lights of different colours; but the riſk of miſtake or failure in the compoſition at the laboratory, makes this rather hazardous. Coloured lanthorns are more certain; but when the glaſſes are made of a colour ſufficiently intenſe, the vivacity of the light (which at no time is very great) is too much diminiſhed. Beſides, the very diſtance changes the colour exceedingly and unaccountably.

III. *Of* SIGNALS *in a* FOG.

THESE can be made only by noiſes, ſuch as the firing of cannon and muſkets, the beating of drums and ringing of bells, &c. Fog ſignals are the moſt difficult to contrive of any, and are ſuſceptible of the leaſt variety. The commander in chief is principally concerned to keep his fleet together; and unleſs ſomething very urgent requires it, he will make no change in his courſe or rate of ſailing. But a ſhift of wind or other cauſes may make this neceſſary. The changes which he will order, it will be prudent to regulate by ſome fixed rule, which is in general convenient. Thus, when a fleet is in the order of ſailing upon a wind, and a fog comes on, the fleet will hold on the ſame courſe. If the wind ſhould come a little more on the beam, the fleet will ſtill keep cloſe to the wind. Certain general rules of this kind being agreed on, no ſignals are neceſſary for keeping the fleet together; and the ſhips can ſeparate or run foul of each other only by difference in their rate of ſailing, or by inaccurate ſteerage. To prevent this, the commander in chief fires a gun from time to time, and the ſhips of the fleet judge of his ſituation and diſtance by the ſound. The commanders of diviſions fire guns, with ſome diſtinction from thoſe of the commander in chief. This both informs the commander in chief of the poſition of his ſquadrons, and enables the private ſhips of each diviſion to keep in the neighbourhood of their own flag ſhip. On board of every private ſhip the drum is beaten, or the bell is chimed, every

23 By obſerving certain general rules ſignals during a fog are in many caſes unneceſſary.

quarter

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quarter of an hour, according as the ſhip is on the ſtarboard or larboard tack. By ſuch contrivances, it is never difficult to keep a fleet in very good order when ſailing on a wind. The wind is almoſt always moderate, and the ſhips keep under a very eaſy ſail. It is much more difficult when going large, and ſeparation can be prevented only by the moſt unwearied attention. The greateſt riſk is the falling in with ſtrange ſhips ſteering another courſe.

But evolutions and other movements are frequently indiſpenſable. The courſe muſt be changed by tacking or wearing, and other ſervices muſt be performed. None, however, are admitted but the moſt probable, the moſt ſimple, and the moſt neceſſary.

24
How they are given when neceſſary.

The commander in chief firſt informs the fleet by the *preparatory fog ſignal*, that he is about to order an evolution, and that he is to direct it by *fog ſignals*. This precaution is indiſpenſable to prevent miſtakes. Along with this advertiſing ſignal he makes the ſignal of the movement intended. This not only calls the attention of the fleet, but makes the ſhips prepare for the preciſe execution of that movement. The commanders of diviſions repeat the advertiſing ſignal, which informs their ſhips of their ſituation, and the private ſhips beat their drums or chime their bells. Thus the whole ſhips of the fleet cloſe a little, and become a little better acquainted with their mutual poſition. It is now underſtood that a movement is to be made preciſely a quarter of an hour after the advertiſement. At the expiration of this time, the effective ſignal for this movement is made by the commander in chief, and muſt be inſtantly repeated by the commanders of diviſions, and then the movement muſt be made by each ſhip, according to the ſailing and fighting inſtructions. This muſt be done with the utmoſt attention and preciſion, becauſe it produces a prodigious change in the relative poſition of the ſhips; and even although the good ſenſe of the commander in chief will ſelect ſuch movements for accompliſhing his purpoſe as produce the ſmalleſt alterations, and the leaſt riſk of ſeparation or running foul of each other; it is ſtill extremely difficult to avoid theſe misfortunes. To prevent this as much as poſſible, each ſhip which has executed the movement, or which has come on a courſe thwarting that of the fleet, intimates this by a ſignal properly adapted, often adding the ſignal of the tack on which it is now ſtanding, and even its particular ſignal of recognizance. This is particularly incumbent on the flag ſhips and the leading ſhips of each diviſion.

After a reaſonable interval, the commander in chief will make proper ſignals for bringing the fleet to a knowledge of their reunion in this new poſition.

25
Improper to publiſh a particular account of ſignals.

This muſt ſerve for a general account of the circumſtances which muſt be attended to in framing a code of ſignals. The arbitrary characters in which the language is written muſt be left to the ſagacity of the gentlemen of the profeſſion. It muſt be obſerved, that the ſtratagems of war make ſecrecy very neceſſary. It may be of immenſe hazard if the enemy ſhould underſtand our ſignals. In time of battle it might frequently fruſtrate our attempts to deſtroy them, and at all times would enable them to eſcape, or to throw us into diſorder. Every commander of a ſquadron, therefore, iſſues private ſignals, ſuited to his particular deſtination; and therefore it is neceſſary that our code of ſignals be ſuſceptible of endleſs variations. This is exceedingly eaſy without any increaſe of their number. The commander needs only intimate that ſuch and ſuch a ſignal is ſo and ſo changed in its meaning during his command.

26
Signals may be made the immediate expreſſions of numbers.

We cannot leave this article without returning to an obſervation which we made almoſt in the beginning, viz. that the ſyſtem of ſignals, or, to ſpeak more properly, the manner of framing this ſyſtem, has received much improvement from the gentlemen of the French navy, and particularly from the moſt ingenious thought of M. de la Bourdonnais, of making the ſignals the immediate expreſſions of *numbers* only, which numbers may be afterwards uſed to indicate any order whatever. We ſhall preſent our readers with a ſcheme or two of the manner in which this may be done for all ſignals, both day, night, and fog. This alone may be conſidered as a ſyſtem of ſignals, and is equally applicable to every kind of information at a diſtance. Without detracting in the ſmalleſt degree from the praiſe due to M. de la Bourdonnais, we muſt obſerve, that this principle of *notation* is of much older date. Biſhop Wilkins, in his Secret and Swift Meſſenger, expreſly recommends it, and gives ſpecimens of the manner of execution; ſo does Dr Hooke in ſome of his propoſals to the Royal Society. Gaſpar Schottus alſo mentions it in his *Technica Curioſa*; and Kircher, among others of his Curious Projects.

27
M. de la Bourdonnais's method for doing this

M. de la Bourdonnais's method is as follows:

He chooſes pendants for his effective ſignals, becauſe they are the moſt eaſily diſplayed in the proper order. Several pendants, making part of one ſignal, may be hoiſted by one hallyard, being ſtopped on it at the diſtance of four or ſix feet from each other. If it be found proper to throw out another ſignal at the ſame time and place, they are ſeparated by a red pendant without a point. His colours are choſen with judgement, being very diſtinctly recogniſed, and not liable to be confounded with the addreſſing ſignals appropriated to the different ſhips of the fleet. They are,

For N° 1. Red.	For N° 6. Red, with blue tail.
2. White.	7. White, with blue tail.
3. Blue.	8. White, with red tail.
4. Yellow.	9. Blue, with yellow tail.
5. Red, with white tail.	10. Yellow, with blue tail.

Three ſets of ſuch pendants will expreſs every number under a thouſand, by hoiſting one above the other, and reckoning the uppermoſt hundreds, the next below it tens, and the loweſt units. Thus the number 643 will be expreſſed by a pendant red with blue tail, a yellow pendant below it, and a blue one below the laſt.

This method has great advantages. The ſignals may be hoiſted in any place where beſt ſeen, and therefore the ſignification is not affected by the derangement of the flag ſhip's maſts and rigging. And by appropriating the ſmaller numbers to the battle ſignals, they are more ſimple, requiring fewer pendants.

28
might be rendered much ſimpler by uſing fewer colours.

As this method requires a particular ſet of colours, it has its inconveniences. An admiral is often obliged to ſhift his flag, even in time of action. He cannot eaſily take the colours along with him. It is therefore better to make uſe of ſuch colours as every private ſhip is provided with. One ſet of 11 will do, with the addition

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dition of three, at moſt of four pendants, of ſingular make, to mark 100, 200, 300, 400. Two of theſe flags, one above the other, will expreſs any number under 100, by uſing the 11th as a ſubſtitute for any flag that ſhould be repeated. Thus the 11th flag, along with the flag for eight or for ſix, will expreſs the number 88 or 66, &c. Thus we are able to expreſs every number below 500, and this is ſufficient for a very large code of ſignals.

And in order to diminiſh as much as poſſible the number of theſe compound ſignals, it will be proper that a number of ſingle flag ſignals be preſerved, and even varied by circumſtances of poſition, for orders which are of very frequent occurrence, and which can hardly occur in ſituations where any obſtructions are occaſioned by loſs of maſts, &c. And farther, to avoid all chance of miſtake, a particular ſignal can be added, intimating that the ſignals now exhibited are numerary ſignals; or, which is ſtill better, all ſignals may be conſidered as numerary ſignals; and thoſe which we have juſt now called *ſingle flag ſignals* may be ſet down oppoſite to, or as expreſſing, the largeſt numbers of the code.

This method requires the ſignal of advertiſement, the annulling ſignal, the ſignal of addreſs to the particular ſhip or diviſion, the ſignal of acknowledgement, the ſignal of indiſtinctneſs, of diſtreſs, of danger, and one or two more which, in every method, muſt be employed.

29 Another method of expreſſing numbers by fewer colours,

Another method of expreſſing numbers with fewer colours is as follows: Let the flags be A, B, C, D, E, F, and arrange them as follows:

	A	B	C	D	E	F
	1	2	3	4	5	6
A	7	8	9	10	11	12
B	13	14	15	16	17	18
C	19	20	21	22	23	24
D	25	26	27	28	29	30
E	31	32	33	34	35	36
F	37	38	39	40	41	42

The number expreſſed by any pair of flags is found in the interſection of the horizontal and perpendicular columns. Thus the flag D, hoiſted along with and above the flag F, expreſſes the number 40, &c. In order to expreſs a greater number (but not exceeding 84) ſuppoſe 75, hoiſt the flags $\frac{C}{E}$, which expreſſes 33, or 75 wanting 42, and above them a flag or ſignal G, which alone expreſſes 42.

30 which may be alſo improved.

This method may be ſtill farther improved by arranging the flags thus:

	A	B	C	D	E	F
	1	2	3	4	5	6
A	7	8	9	10	11	12
B	—	13	14	15	16	17
C	—	—	18	19	20	21
D	—	—	—	22	23	24
E	—	—	—	—	25	26
F	—	—	—	—	—	27

In this laſt method the ſignification of the ſignal is totally independent of the poſition of the flags. In whatever parts of the ſhip the flags D and E are ſeen, they expreſs the number 23. This would ſuit battle ſignals.

31 third method

Another method ſtill may be taken. Flags hoiſted anywhere on the foremaſt may be accounted units, thoſe on the mainmaſt tens, and thoſe on the mizenmaſt hundreds. Thus numeral ſignals may be made by a ſhip diſmaſted, or having only poles in their place.

Many other ways may be contrived for expreſſing numbers by colours, and there is great room for exerciſing the judgement of the contriver. For it muſt always be remembered, that theſe ſignals muſt be accompanied with a ſignal by which it is addreſſed to ſome particular ſhip or diviſion of the fleet, and it may be difficult to connect the one with the other, which is perhaps ſhown in another place, and along with other executive ſignals.

32 Advantages of numeral ſignals.

One great advantage of theſe numeral ſignals is, that they may be changed in their ſignification at pleaſure. Thus, in the firſt method, it can be ſettled, that on Sundays the colours A, B, C, D, &c. expreſs the cyphers, 1, 2, 3, 4, &c. but that on Mondays they expreſs the cyphers 0, 1, 2, 3, &c. and on Tueſdays the cyphers 9, 0, 1, 2, &c.; and ſo on through all the days of the week. This mean of ſecrecy is mentioned by Dr Hooke for the coaſt and alarm ſignals, where, by the by, he ſhews a method for conveying intelligence over land very ſimilar to what is now practiſed by the French with their telegraph.

33 Numbers may be alſo expreſſed by night ſignals.

It is equally eaſy to expreſs numbers by night ſignals. Thus M. de la Bourdonnais propoſes, that one diſcharge of a great gun ſhall expreſs 7, and that 1, 2, 3, 4, 5, 6 ſhall be expreſſed by lights. Therefore, to expreſs 24, we muſt fire three guns, and ſhow three lights. This is the moſt perfect of all forms of night and fog ſignals. For both the manner of firing guns and of exhibiting lights may be varied to a ſufficient extent with very few guns or lights, and with great diſtinctneſs.

Thus, for guns. Let F mark the firing of a ſingle gun at moderate intervals, and *ff* a double gun, that is, two diſcharged at the interval of a ſecond. We may expreſs numbers thus:

1	F.
2	F, F.
3	F, F, F.
4	F, F, F, F.
5	F, *ff*.
6	F, F, *ff*.
7	F. *ff*, F.
8	F, *ff*, F, F.
9	F, *ff*, F, *ff*.
10	*ff*.
100, &c.	*ff*, *ff*, or *fff*.

It might be done with fewer guns if the *ff* were admitted as the firſt firing. But it ſeems better to begin always with the ſingle gun, and thus the double gun beginning a ſignal diſtinguiſhes the tens &c.

In like manner, a ſmall number of lights will admit of a great variety of very diſtinct poſitions, which may ſerve for all ſignals to ſhips not very remote from the commander in chief. For orders to be underſtood at a very great diſtance, it will be proper to appropriate the numbers which are indicated by ſignals made with rockets.

rockets. Thefe can be varied in number and kind to a fufficient extent, fo as to be very eafily diftinguifhed and underftood. It is fufficient to have fhown how the whole, or nearly the whole, notation of fignals may be limited to the expreffion of numbers.

34 Concluding remarks.

We have taken little notice of the fignals made by private fhips to the commander in chief. This is a very eafy bufinefs, becaufe there is little rifk of confounding them with other fignals. Nor have we fpoken of fignals from the flag fhips whofe ultimate interpretation is number, as when fhips are directed to change their courfe fo many points. Thofe alfo are eafily contrived in any of the methods already defcribed : alfo when a private fhip wifhes to inform the commander in chief that foundings are found at fo many fathoms. In like manner, by numbering the points of the compafs, the admiral can direct to chace to any one of them, or may be informed of ftrange fhips being feen in any quarter, and what is their number.

SIGNALS by the Drum, made ufe of, in the exercife of the army, inftead of the word of command, viz.

Signals.	*Operations.*
A fhort roll, -	To caution.
A flam, -	To perform any diftinct thing.
To arms, - -	To form the line or battalion.
The march, -	To advance, except when intended for a falute.
The quick march, -	To advance quick.
The point of war, -	To march and charge.
The retreat, -	To retreat.
Drum ceafing, -	To halt.
Two fhort rolls, -	To perform the flank firing.
The dragoon march,	To open the battalion.
The grenadier march,	To form the column.
The troop, -	To double divifions.
The long roll, -	To form the fquare.
The grenadier march,	To reduce the fquare to the column.
The preparative, -	To make ready and fire.
The general, -	To ceafe firing.
Two long rolls, -	To bring or lodge the colours.

SIGNATURE, a fign or mark impreffed upon any thing, whether by nature or art. Such is the general fignification of the word ; but in the plural number it has been ufed, in a particular fenfe, to denote thofe external marks by which phyfiognomifts and other dabblers in the occult fciences pretend to difcover the nature and internal qualities of every thing on which they are found. According to Lavater, every corporeal object is characterized by fignatures peculiar to itfelf.

The doctrine of fignatures, like alchemy and aftrology, was very prevalent during the 15th and 16th centuries ; and was confidered as one of the occult fciences which conferred no fmall degree of honour on their refpective profeffors. Some of thefe philofophers, as they thought fit to ftyle themfelves, maintained that plants, minerals, and animals, but particularly plants, had fignatures impreffed on them by the hand of nature, indicating to the adept the *therapeutic* ufes to which they might be applied. Others, fuch as the myftic theofophifts and chemifts of that day, proceeded much farther in abfurdity, maintaining that every fubftance in nature had either *external* fignatures immediately difcernible, or *internal* fignatures, which, when brought into view by fire or menftrua, denoted its connection with fome fidereal or celeftial archetype. Of the doctrine of fignatures, as it relates merely to the therapeutic ufes of plants and minerals, traces are to be found in the works of fome of the greateft authors of antiquity ; but the celeftial fignatures, we believe, were difcovered only by the moonlight of the monkifh ages. Pliny informs us *, that the marble called *aphites*, from its being fpotted like a ferpent, was difcovered by thofe fpots to be a fovereign remedy for the bite of that animal ; and that the colour of the *hæmatites* or blood-ftone intimated that it was fit to be employed to ftop an hemorrhagy ; but we do not recollect his attributing the virtues of thefe minerals to a fidereal or celeftial influence.

* *Hift. Nat.* lib. 34.

SIGNATURE, a figning of a perfon's name at the bottom of an act or deed written by his own hand.

SIGNATURE, in *Printing*, is a letter put at the bottom of the firft page at leaft, in each fheet, as a direction to the binder in folding, gathering, and collating them. The fignatures confift of the capital letters of the alphabet, which change in every fheet ; if there be more fheets than letters in the alphabet, to the capital letter is added a fmall one of the fame fort, as A a, B b ; which are repeated as often as neceffary. In large volumes it is eafy to diftinguifh the number of alphabets, after the firft three or four, by placing a figure before the fignature, as 5 B, 6 B, &c.

SIGNET, one of the king's feals, made ufe of in fealing his private letters, and all grants that pafs by bill figned under his majefty's hand : it is always in the cuftody of the fecretaries of ftate.

SIGNET, in *Scots Law*. See LAW, Part III. § 17.

SILENE, CATCHFLY, or *Vifcous Campion*, a genus of plants belonging to the clafs *decandria*, and order *trigynia* ; and in the natural fyftem arranged under the 22d order, *caryophylleæ*. See BOTANY *Index*.

SILESIA, a duchy of Germany, bounded on the eaft by Poland ; on the weft, by Bohemia and Lower Lufatia ; on the fouth, by a chain of mountains, and a thicket of confiderable extent which feparates it from Hungary ; and to the north, by the marquifate of Brandenburg and Poland. From north-weft to fouth-eaft it is about 274 miles, and about 100 where broadeft : but it is much contracted at both ends. Upon the frontiers of this country, to the weft and fouth, are very high mountains, and fome likewife in other parts of it. One of the ridges upon the frontiers is ftyled the *Riphæan Mountains*, another the *Moravian*, another the *Bohemian*, and another the *Hungarian*, *Crapack*, or *Carpathian*. A branch of the Bohemian is called the *Giant Mountains*. The winter on thefe hilly tracts is more fevere, fets in fooner, and lafts longer, than in the low lands. The inhabitants ufe a kind of fkates when the fnow is deep, as they do in Carniola. Little or no grain is raifed in the mountains and fome fandy tracts ; but the reft of the country is abundantly fruitful, not only in grain, but fruits, roots, pafture, flax, hops, madder, tobacco, and hemp, yielding alfo fome wine, with confiderable quantities of filk and honey. In many places are great woods of pines, fir, beech, larch, and other trees, affording tar, pitch, rofin, turpentine, lamp-black, and timber for all ufes. In this country alfo is found marble of feveral forts, fome precious ftones, lime-ftone, millftone, pitcoal, turf, vitriol, fome filver ore, copper, lead, iron, and mineral fprings. Great numbers

bers of black cattle and horses are brought hither from Poland and Hungary for sale, those bred in the country not being sufficient; but of sheep, goats, game, and venison, they have great plenty. As for wild beasts, here are lynxes, foxes, weasels, otters, and beavers. The rivers, lakes, and ponds, yield fish of several sorts, particularly sturgeons several ells in length, and salmon. Besides a number of smaller streams to water this country, there is the Oder, which traverses it almost from one end to the other; and the Vistula, which after a pretty long course through it enters Poland. The number of the cities and market-towns is said to be about 200, the county of Glatz included, and that of the villages 5000. The inhabitants, who are computed to be about 1,821,065 are a mixture of Germans, Poles, and Moravians. The language generally spoken is German; but in some places the vulgar tongue is a dialect of the Sclavonic. The states consist of the princes and dukes, and those called *state-lords*, with the nobility, who are immediately subject to the sovereign, and the representatives of the chief cities; but since the country fell under the dominion of the king of Prussia, no diets have been held. The king, however, when he took possession of the country, confirmed all the other privileges of the inhabitants. With respect to religion, not only Protestants, but Papists, Jews, and Greeks, enjoy full liberty of conscience. The greatest part of Silesia lies in the diocese of Breslaw, but some part of it in the Polish dioceses of Posen and Cracow. The bishop of Breslaw stands immediately under the pope with regard to spirituals; but all ecclesiastical benefices, not excepting the see of Breslaw, is in the king's gift. Besides Latin schools, colleges, and seminaries, at Breslaw is an university, and at Lignitz an academy for martial exercises. The principal manufactures here are woollens, linens, and cottons of several sorts, with hats, glass-ware, gunpowder, and iron manufactures. Of these there is a considerable exportation. Accounts are generally kept in rix-dollars, silver groschens, and ducats. With respect to its revolutions and present government, it was long a part of the kingdom of Poland; afterwards it had several dukes and petty princes for its sovereigns, who by degrees became subject to the kings of Bohemia, until at last King Charles IV. incorporated the whole duchy with Bohemia; and thus it continued in the possession of the house of Austria, until the king of Prussia in 1742, taking advantage of the troubles that ensued upon the death of the emperor Charles VI. and pretending a kind of claim, wrested a great part of it, together with the county of Glatz, from his daughter and heiress Maria Theresa, the late empress dowager; so that now only a small part of it is possessed by the house of Austria, and connected with the empire, the rest being governed by the king of Prussia, without acknowledging any sort of dependence on the crown of Bohemia or the empire. For the administration of justice in all civil, criminal, and feudal cases, and such as relate to the revenue, the king of Prussia has established three supreme judicatories, to which an appeal lies from all the inferior ones, and from which, when the sum exceeds 500 rix-dollars, causes may be moved to Berlin. The Lutheran churches and schools are under the inspection of the upper consistories, and those of the Papists under that of the bishop's court at Breslaw; but from both an appeal lies to the tribunal at Berlin. As to the revenue, the excise here is levied only in the walled towns, being on the same footing as in the marquisate of Brandenburg; but in the rest of the country the contributions are fixed, and the same both in peace and war. The several branches of the revenue are under the management of the war and domain offices of Breslaw and Glogau. The whole revenue arising to the king of Prussia from Silesia and the county of Glatz amounts to about four millions of rix-dollars per annum.

Silesia is divided into Upper and Lower, and each of these again into principalities and lordships; of some of which both the property and jurisdiction belong immediately to the sovereign, but of others to his subjects and vassals. In regard to the character of the people, the boors are accounted very dull and stupid; but of those of a higher rank, many have distinguished themselves by their wit and learning, as well as by their military and political talents.

SILESIAN EARTH, in the *Materia Medica*, a fine astringent bole. It is very heavy, of a firm compact texture, and in colour of a brownish yellow. It breaks easily between the fingers, and does not stain the hands; is naturally of a smooth surface, is readily diffusible in water, and melts freely into a butter-like substance in the mouth. It leaves no grittiness between the teeth, and does not ferment with acids. It is found in the perpendicular fissures of rocks near the gold mines in Hungary.

SILICERNIUM, among the Romans, was a feast of a private nature, provided for the dead some time after the funeral. It consisted of beans, lettuces, bread, eggs, &c. These were laid upon the tomb, and they foolishly believed that the dead would come out for the repast. What was left was generally burnt on the stone. The word *silicernium* is derived from *silex* and *cæna*, i. e. "a supper upon a stone." Eating what had thus been provided for the dead, was esteemed a mark of the most miserable poverty. A similar entertainment was made by the Greeks at the tombs of the deceased; but it was usual among them to treat the ghosts with the fragments from the feast of the living. See FUNERAL and INFERIÆ.

SILEX. See FLINT.

SILICEOUS EARTHS. See SILICA, CHEMISTRY *Index*.

SILIUS ITALICUS, CAIUS, an ancient Roman poet, and author of an epic poem in 17 books, which contains an history of the second Punic war, so famous for having decided the empire of the world in favour of the Romans. He was born in the reign of Tiberius, and is supposed to have derived the name of *Italicus* from the place of his birth; but whether he was born at Italica in Spain, or at Corfinium in Italy, which, according to Strabo, had the name of *Italica* given it during the Social war, is a point which cannot be known; though, if his birth had happened at either of these places, the grammarians would tell us, that he should have been called *Italicensis*, and not *Italicus*. When he came to Rome, he applied himself to the bar; and, by a close imitation of Cicero, succeeded so well, that he became a celebrated advocate and most accomplished orator. His merit and character recommended him to the highest offices in the republic, even to the consulship, of which he was possessed when Nero died. He is said to

Silius, Silk. have been aiding and affifting in accufing perfons of high rank and fortune, whom that wicked emperor had devoted to deftruction: but he retrieved his character afterwards by a long and uniform courfe of virtuous behaviour. Vefpafian fent him as proconful into Afia, where he behaved with clean hands and unblemifhed reputation. After having thus fpent the beft part of his life in the fervice of his country, he bade adieu to public affairs, refolving to confecrate the remainder to polite retirement and the mufes. He had feveral fine villas in the country: one at Tufculum, celebrated for having been Cicero's; and a farm near Naples, faid to have been Virgil's, at which was his tomb, which Silius often vifited. Thus Martial compliments him on both thefe accounts:

Silius hæc magni celebrat monumenta Maronis,
Jugera facundi qui Ciceronis habet.
Hæredem Dominumque fui tumulique larifque
Non alium mallet nec Maro nec Cicero.
Epigr. 49. lib. xi.

Of Tully's feat my Silius is poffefs'd,
And his the tomb where Virgil's afhes reft.
Could thofe great fhades return to choofe their heir,
The prefent owner they would both prefer.

In thefe retirements he applied himfelf to poetry: led not fo much by any great force of genius, which would certainly not have fuffered him to ftay till life was in the wane and his imagination growing cold, as by his exceeding great love of Virgil, to whofe memory he paid the higheft veneration. He has imitated him in his poem; and though he falls infinitely fhort of him, yet he has difcovered a great and univerfal genius, which would have enabled him to fucceed in fome degree in whatever he undertook.

Having been for fome time afflicted with an impofthume, which was deemed incurable, he grew weary of life, to which, in the language of Pliny, he put an end with determined courage.

There have been many editions of Silius Italicus. A neat and correct one was publifhed at Leipfic in 1696, in 8vo, with fhort and ufeful notes by Cellarius: but the beft is that *cum notis integris variorum et Arnoldi Drakenborch.* Traject. ad Rhen. 1717, in 4to.

SILK, a very foft, fine, bright thread, the work of an infect called *bombyx*, or the filk worm.

As the filk worm is a native of China, the culture of filk in ancient times was entirely confined to that country. We are told that the empreffes, furrounded by their women, fpent their leifure hours in hatching and rearing filk worms, and in weaving tiffues and filk veils. That this example was foon imitated by perfons of all ranks, we have reafon to conclude; for we are informed that the Chinefe, who were formerly clothed in fkins, in a fhort time after were dreffed in veftments of filk. Till the reign of Juftinian, the filk worm was unknown beyond the territories of China, but filk was introduced into Perfia long before that period. After the conqueft of the Perfian empire by Alexander the Great, this valuable commodity was brought into Greece, and thence conveyed to Rome. The firft of the Roman writers extant by whom filk is mentioned, are Virgil and Horace; but it is probable that neither of them knew from what country it was obtained, nor how it was produced. By fome of the ancients it was fuppofed to be a fine down adhering to the leaves of certain trees or flowers. Others imagined it to be a delicate fpecies of wool or cotton; and even thofe who had learned that it was the work of an infect, fhow by their defcriptions that they had no diftinct idea of the manner in which it was formed. Among the Romans, filk was deemed a drefs too expenfive and too delicate for men, and was appropriated wholly to women of eminent rank and opulence. Elagabulus is faid to have been the firft man among the Romans who wore a garment of fine filk: Aurelian complained that a pound of filk was fold at Rome for 12 ounces of gold; and it is faid he refufed to give his wife permiffion to wear it on account of its exorbitant price.

1 Opinions of the ancients concerning the nature of filk.

2 Brought from China by the Perfians till the time of Juftinian.

For feveral centuries the Perfians fupplied the Roman empire with the filks of China. Caravans traverfed the whole latitude of Afia, in 243 days, from the Chinefe ocean to the fea-coaft of Syria, carrying this commodity. Sometimes it was conveyed to the ports of Guzerat and Malabar, and thence tranfported by fea to the Perfian gulf. The Perfians, with the ufual rapacity of monopolifts, raifed the price of filk to fuch an exorbitant height, that Juftinian, eager not only to obtain a full and certain fupply of a commodity which was become of indifpenfable ufe, but folicitous to deliver the commerce of his fubjects from the exactions of his enemies, endeavoured, by means of his ally, the Chriftian monarch of Abyffinia, to wreft fome portion of the filk trade from the Perfians. In this attempt he failed; but when he leaft expected it, he, by an unforefeen event, attained, in fome meafure, the object which he had in view. Two Perfian monks having been employed as miffionaries in fome of the Chriftian churches, which were eftablifhed (as we are informed by Cofmas) in different parts of India, had penetrated into the country of the Seres, or China. There they obferved the labours of the filk worm, and became acquainted with all the arts of man in working up its productions into fuch a variety of elegant fabrics. The profpect of gain, or perhaps an indignant zeal, excited by feeing this lucrative branch of commerce engroffed by unbelieving nations, prompted them to repair to Conftantinople. There they explained to the emperor the origin of filk, as well as the various modes of preparing and manufacturing it, myfteries hitherto unknown, or very imperfectly underftood in Europe; and encouraged by his liberal promifes, they undertook to bring to the capital a fufficient number of thofe wonderful infects, to whofe labours man is fo much indebted. This they accomplifhed, by conveying the eggs of the filk worm in a hollow cane. They were hatched by the heat of a dunghill, fed with the leaves of a wild mulberry tree, and they multiplied and worked in the fame manner as in thofe climates where they firft became objects of human attention and care. Vaft numbers of thefe infects were foon reared in different parts of Greece, particularly in the Peloponnefus. Sicily afterwards undertook to breed filk worms with equal fuccefs, and was imitated, from time to time, in feveral towns of Italy. In all thefe places extenfive manufactures were eftablifhed and carried on with filk of domeftic production. The demand for filk from the eaft diminifhed of courfe, the fubjects of the Greek emperors were no longer obliged to have recourfe to the Perfians for a fupply of it, and a confiderable change took place in

Robertfon's Difquifition concerning India, p. 58.

3 Silk worms introduced into Europe by two monks.

in the nature of the commercial intercourfe between Europe and India.

As filk is the production of a worm, it will be firft neceffary to give a defcription of its nature and mode of manufacturing. But before we give any account of the moft approved methods of managing filk worms in Europe, it will be proper to prefent a fhort defcription of the methods practifed in China, the original country of the filk worm. Thefe are two: they either permit them to remain at liberty on mulberry trees, or keep them in rooms. As the fineft filk is produced by worms confined in rooms, and as the firft method is very fimple, it will fuffice to defcribe the fecond.

4 Method of rearing filk worms in China.

To begin with the eggs, which are laid on large fheets of paper, to which they firmly adhere. The fheets are hung up on a beam of the room, with the eggs inward, and the windows are opened in the front to admit the wind; but no hempen ropes muft ever come near the worms or their eggs. After fome days the fheets are taken down, rolled up loofely with the eggs inward, and then hung up again, during the fummer and autumn. At the end of December, or the beginning of January, the eggs are put into cold water, with a little falt diffolved in it. Two days after they take them out, hang them up again, and when dry roll them a little tighter, and enclofe each feparately, ftanding on one end in an earthen veffel. Some put them into a lye made of mulberry tree afhes, and then lay them fome moments in fnow-water, or elfe hang them up three nights on a mulberry tree to receive the fnow or rain, if not too violent. The time of hatching them is when the leaves of the mulberry trees begin to open, for they are haftened or impeded according to the different degrees of heat or cold to which they are expofed. When they are ready to come forth, the eggs fwell, and become a little pointed.

The third day before they are hatched, the rolls of paper are taken out of the veffel, ftretched out, and hung up with their backs toward the fun, till they receive a kindly warmth; and then being rolled up clofe, they are fet upright in a veffel in a warm place. This is repeated the next day, and the eggs change to an afh-gray. They then put two fheets together, and rolling them clofe tie the ends.

The third day, towards night, the fheets are unrolled and ftretched on a fine mat, when the eggs appear blackifh. They then roll three fheets together, and carry them into a pretty warm place, fheltered from the fouth wind. The next day the people taking out the rolls, and opening them, find them full of worms like fmall black ants.

The apartment chofen for filk worms is on a dry ground, in a pure air, and free from noife. The rooms are fquare, and very clofe, for the fake of warmth; the door faces the fouth, and is covered with a double mat, to keep out the cold; yet there fhould be a window on every fide, that when it is thought neceffary the air may have a free paffage. In opening a window to let in a refrefhing breeze, care muft be taken to keep out the gnats and flies. The room muft be furnifhed with nine or ten rows of frames, about nine inches one above the other. On thefe they place rufh hurdles, upon which the worms are fed till they are ready to fpin; and, to preferve a regular heat, ftove fires are placed at the corners of the room, or elfe a warming pan is carried up and down it; but it muft not have the leaft flame or fmoke. Cow-dung dried in the fun is efteemed the moft proper fuel.

The worms eat equally day and night. The Chinefe give them on the firft day forty-eight meals, that is, one every half hour; the next thirty; the third day they have ftill lefs. As cloudy and rainy weather takes away their ftomach, juft before their repaft a wifp of very dry ftraw, the flame of which muft be all alike, is held over the worms to free them from the cold and moifture that benumbs them, or elfe the blinds are taken from the windows to let in the full day-light.

Eating fo often haftens their growth, on which the chief profit of the filk worm depends. If they come to maturity in 23 or 25 days, a large fheet of paper covered with worms, which at their firft coming from the eggs weigh little more than a drachm, will produce 25 ounces of filk; but if not till 28 days, they then yield only 20 ounces; and if they are a month or 40 days in growing, they then produce but ten.

They are kept extremely clean, and are often removed; and when they are pretty well grown, the worms belonging to one hurdle are divided into three, afterwards they are placed on fix, and fo on to the number of 20 or more; for being full of humours, they muft be kept at a due diftance from each other. The critical moment for removing them is when they are of a bright yellow and ready to fpin; they muft be furrounded with mats at a fmall diftance, which muft cover the top of the place to keep off the outward air; and becaufe they love to work in the dark. However, after the third day's labour, the mats are taken away from one o'clock till three, but the rays of the fun muft not fhine upon them. They are at this time covered with the fheets of paper that were ufed on the hurdles.

The cocoons are completed in feven days, after which the worm is metamorphofed into a chryfalis; the cocoons are then gathered, and laid in heaps, having firft fet apart thofe defigned for propagation upon a hurdle, in a cool airy place. The next care is to kill the moths in thofe cones which are not to be bored. The beft way of doing this is to fill large earthen veffels with cones in layers of ten pounds each, throwing in four ounces of falt with every layer, and covering it with large dry leaves like thofe of the water-lily, and clofely ftopping the mouth of the veffels. But in laying the cones into the veffels, they feparate the long, white, and glittering ones, which yield a very fine filk, from thofe that are thick, dark, and of the colour of the fkin of an onion, which produce a coarfer filk.

5 Defcription and hiftory of the filk worm.

The filk worm is a fpecies of caterpillar, which, like all others of the fame clafs, undergoes a variety of changes, that, to perfons who are not acquainted with objects of this kind, will appear to be not a little furprifing.

It is produced from a yellowifh-coloured egg, about the fize of a fmall pin-head, which has been laid by a kind of grayifh-coloured moth, which the vulgar confound with the butterfly. *The Bee*, N° 72.

Thefe eggs, in the temperature of this climate, if kept beyond the reach of the fire and funfhine, may be preferved during the whole of the winter and fpring months without danger of hatching: and even in fummer they may eafily be prevented from hatching if they be kept in a cool place; but in warmer climates it is

Silk.

scarcely possible to preserve them from hatching, even for a few days, or from drying so much as to destroy them. Hence it is easy for a native of Britain to keep the eggs till the food on which the worm is to feed be ready for that purpose. When this food is in perfection, the eggs need only be exposed to the sun for a day or two, when they will be hatched with great facility.

When the animal is first protruded from the egg, it is a small black worm, which is active, and naturally ascends to the top of the heap in search of food. At this stage of his growth the silk worm requires to be fed with the youngest and most tender leaves. On these leaves, if good, he will feed very freely for about eight days, during which period he increases in size to about a quarter of an inch in length. He is then attacked with his first sickness, which consists in a kind of lethargic sleep for about three days continuance; during which time he refuses to eat, and changes his skin, preserving the same bulk. This sleep being over, he begins to eat again, during five days, at which term he is grown to the size of full half an inch in length; after which follows a second sickness in every respect like the former.

He then feeds for other five days; during which time he will have increased to about three quarters of an inch in length, when he is attacked with his third sickness. This being over, he begins to eat again, and continues to do so for five days more, when he is attacked by his fourth sickness, at which time he is arrived at his full growth. When he recovers this sickness, he feeds once more during five days with a most voracious appetite; after which he disdains his food, becomes transparent, a little on the yellowish cast, and leaves his silky traces on the leaves where he passes. These signs denote that he is ready to begin his cocoon, and will eat no more.

Thus it appears that the whole duration of the life of the worm, in this state of its existence, in our climate, is usually about 46 days; 28 of which days he takes food, and remains in his sick or torpid state 18; but it is to be observed, that during warm weather the periods of sickness are shortened, and in cold weather lengthened, above the terms here specified. In very hot climates it may be said to live faster, and sooner to attain maturity, than in those that are colder. Dr Anderson informs us, that at Madras the worm undergoes its whole evolutions in the space of 22 days. It appears, however, that it feeds fully as many days in India as in Europe, the difference being entirely occasioned by shortening the period of sickness. The longest sickness he had seen them experience there did not exceed two days; and during summer it only lasts a few hours.

When the worm has attained its full growth, it searches about for a convenient place for forming its cocoon, and mounts upon any branches or twigs that are put in its way for that purpose. After about two days spent in this manner, it settles in its place, and forms the cocoon, by winding the silk which it draws from its bowels round itself into an oblong roundish ball.

During this operation it gradually loses the appearance of a worm; its length is much contracted, and its thickness augmented. By the time the web is finished, it is found to be transformed into an oblong roundish ball, covered with a smooth shelly skin, and appears to be perfectly dead. In this state of existence it is called an *aurelia*. Many animals in this state may be often seen sticking on the walls of out-houses, somewhat resembling a small bean.

In this state it remains for several days entirely motionless in the heart of the cocoon, after which it bursts like an egg hatching, and from that comes forth a heavy dull-looking moth with wings; but these wings it never uses for flying; it only crawls slowly about in the place it has been hatched. This creature forces its way through the silk covering which the worm had woven, goes immediately in quest of its mate, after which the female lays her eggs; and both male and female, without tasting food in this stage of their existence, die in a very short time.

The silk worm, when at its full size, is from an inch and a quarter to an inch and a half in length, and about half an inch in circumference. He is either of a milk or pearl colour, or blackish; these last are esteemed the best. His body is divided into seven rings, to each of which are joined two very short feet. He has a small point like a thorn exactly above the anus. The substance which forms the silk is in his stomach, which is very long, wound up, as it were, upon two spindles, as some say, and surrounded with a gum, commonly yellowish, sometimes white, but seldom greenish. When the worm spins his cocoon, he winds off a thread from each of his spindles, and joins them afterwards by means of two hooks which are placed in his mouth, so that the cocoon is formed of a double thread. Having opened a silk worm, you may take out the spindles, which are folded up in three plaits, and, on stretching them out, and drawing each extremity, you may extend them to near two ells in length. If you then scrape the thread so stretched out with your nail, you scrape off the gum, which is very like bees wax, and performs the same office to the silk it covers as gold leaf does to the ingot of silver it surrounds, when drawn out by the wire drawer. This thread, which is extremely strong and even, is about the thickness of a middling pin.

6
Particular attention ought to be paid to the breed of silk worms.

Of silk worms, as of most other animals, there is a considerable variety of breeds, some of which are much more hardy, and possess qualities considerably different from others. This is a particular of much importance to be adverted to at the time of beginning to breed these creatures in any place; for it will make a great difference in the profit on the whole to the undertaker if he rears a good or a bad sort (A). This is a department in respect to the economy of animals that has been in every

(A) As the success of the silk manufacture must depend on the breed of worms, it is of great consequence to bring them from those countries where they are reckoned best.

Mr Andrew Wright, an ingenious silk manufacturer of Paisley, has given the following directions for conveying the eggs of the silk worm from distant countries by sea: As soon as the moth has laid her eggs, dry them immediately, and put them into glass phials; seal them so close that damp air or water will not penetrate into them. Put these phials that contain the eggs into earthen pots filled with cold water; and as often as the water becomes warm

Silk. every cafe much lefs adverted to than it deferves; and in particular with regard to the filk worm it has been almoft entirely overlooked. A few eggs of the filk worm can be eafily tranfported by poft in a letter from any part of Europe to another, efpecially during the winter feafon. It would therefore be an eafy matter for any patriotic fociety, fuch as the Society of Arts in London, to obtain a fpecimen of the eggs from every country in which filk is now reared, to put thefe under the care of a perfon who could be depended upon, and who underftood the management of them, with orders to keep each kind diftinct from another, and advert to every particular that occurred in their management, fo as to make a fair eftimate of their refpective merits. By thefe means the beft might be felected, and thofe of inferior value rejected. Forty or fifty of each fort might be enough for the experiment; but it ought to be repeated feveral times before conclufions could be drawn from it that might be altogether relied upon; for it is well known that a variation of circumftances will make a change in the refult; and it is by no means certain that the fame particular would affect thofe of one breed exactly in the fame manner as it would do thofe of a different breed. One may be more hardy with regard to cold, another more delicate in refpect to food, and fo on. It is experience alone that can afcertain the circumftances here inquired for.

7 The management of filk worms muft be different in different climates;

From the above-mentioned particulars, it is evident, that the management of filk worms muft be very different in hot climates from what is required in thofe that are colder. At Madras, it appears from Dr Anderfon's experiments that it is very difficult to prevent the eggs from hatching for a very few days, fo that many generations of them muft be propagated in one year. "In this hotteft feafon," fays he, in a letter to Sir Jofeph Banks, dated July 6. 1791, "the fhorteft time I have been able to remark for the whole evolutions of the filk worm is 40 days; that is to fay, fix days an egg, 22 a worm, 11 a grub in the cocoon, and one a moth or butterfly." Fortunately, where the climate forces forward their production fo rapidly, nature hath been equally provident of food for their fubfiftence; for in thefe regions the mulberry continues to grow and pufh out leaves throughout the whole year.

8 but may be eafily reared in temperate climes.

Though the filk worm be a native of China, there is no doubt but it might eafily be propagated perhaps in moft parts of the temperate zones. The eggs of this infect, indeed, require a confiderable degree of warmth to hatch them, but they can alfo endure a fevere froft. No lefs than 5400lbs of filk were raifed in 1789 in the cold, fandy territories of Pruffia. In the province of Pekin, in China, where great quantities of filk are fabricated, the winter is much colder than even in Scotland. From the information of fome Ruffians who were fent thither to learn the Chinefe language, we find that Reaumur's thermometer was obferved from 10 to 15, and even 20 degrees below the freezing point. Nor is it difficult to rear the food of the filk worm in a temperate clime. The mulberry-tree is a hardy vegetable, which bears, without injury, the winters of Sweden, and even of Siberia. Of the feven fpecies of the mulberry (fee MORUS) enumerated by Linnæus, four of thefe (viz. the white, red, black, and Tartarian), there is every reafon to believe could be reared both in Britain and Ireland. The *white* grows in Sweden; the *red* is abundant round Quebec; the *black* delights in bleak fituations, expofed to wind on the fea fhore; and the *Tartarian* mulberry is reprefented as growing in the chilly regions of Siberia.

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9 Whether any fpecies of mulberry tree be fuperior to others.

As to the fuperior qualities of the different fpecies, probably there is very little to be pointed out amongft the four juft mentioned with regard to nourifhment, except what may be drawn from the following fact: that if the firft three are laid down together, the filk worm will firft eat the white, then the red, and next the black, in the order of the tendernefs of the leaves. The Tartarian feems to hold as high a place in its efteem as either the red or black; but all muft yield to the white, which feems to be its natural food.

In Calabria the red mulberry is ufed; in Valencia the white; and in Granada, where excellent filk is produced, the mulberries are all black. The white feems to profper very well in a moift ftiff foil: the black agrees well with a dry, fandy, or gravelly foil; and the white is moft luxuriant in a moift rich loam.

10 Britain poffeffes fome advantages over warmer countries for raifing filk.

It may juftly be afferted, that Britain poffeffes fome advantages in the raifing of raw filk which are not enjoyed by warmer countries. Even in the fouth of France, Mr Arthur Young informs us, the mulberry leaves are often nipped by froft in the bud; but this is fcarcely ever the cafe with us. It is well known that thunder and lightning are hurtful to the filk worm. Now our climate can boaft that it is almoft wholly exempted from thofe dreadful ftorms of thunder and lightning which prevail fo much in hot climates. Nature has then furnifhed us with every thing requifite for the filk manufacture; it remains only for us to improve the advantages which we poffefs. Let mulberry trees be planted by proprietors of lands, and let a few perfons of fkill and attention devote their time to the raifing of filk worms. This is an employment that will not interfere with any manufacture already eftablifhed; on the contrary, it would afford a refpectable, a lucrative, and agreeable employment to ladies, or to females in general, who have at prefent too few profeffions to which they can apply. The fociety inftituted at London for the encouragement of arts, manufactures, and commerce, much to their honour, have offered premiums to thofe who fhall plant a certain number of mulberry trees.

11 Method of raifing mulberry-trees in the fouth of France.

The following method of raifing mulberry trees from feed is practifed in the fouth of France, and has been repeated with fuccefs in the Eaft Indies by Dr Anderfon of Madras. "Take the ripe berries of the mulberry when it is full of juice and of feeds. Next take a rough horfe-hair line or rope, fuch as we dry linen on, and with a good handful of ripe mulberries run your hand along the line bruifing the berries and mafhing them

Letters on the Culture of Raw Silk on the Coaft of Coromandel.

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warm renew it. Place the earthen veffels in the coldeft place of the fhip, and let them remain until the end of the voyage. It muft be obferved, that the fhip chofen for this purpofe ought to be one that would arrive in Britain in the months of June or July.

them as much as poffible as your hand runs along, fo that the pulp and feeds of the berries may adhere in great abundance to the rope or hair line. Next dig a trench in the ground where you wifh to plant them, much like what is practifed in kitchen gardens in England for crops of various kinds. Next cut the rope or hair line into lengths according to the length of the trench you think fit to make, and plunge the line full of mafhed berries into the trench, and then cover it over well with earth, always remembering afterwards to water it well, which is effential to the fuccefs. The feeds of the berries thus fown will grow, and foon fhoot out young fuckers, which will bear young leaves, which are the beft food for the filk worm.

"The facility and rapidity with which young leaves may by this means be produced is evident, for as many rows of trenches may thus be filled as can be wifhed; and it can never be neceffary to have mulberry trees higher than our rafpberries, currants, or goofeberry bufhes. Whenever they get beyond that, they lofe their value; and if thefe trenches fucceed, you may have a fupply coming frefh up day after day, or any quantity you pleafe." Thus abundance of thefe trees might be reared. But as mulberry trees are not yet found in abundance in this country, it were to be wifhed that fome other food could be fubftituted in their place: attempts have accordingly been made by thofe who have reared filk worms, and it has been found poffible to fupport the filk worm upon lettuce (B).

Bee, N° 70.

12 Mifs Rhodes fed filk worms on lettuce for fome time.

Mifs Henrietta Rhodes, a lady who has made fome fuccefsful experiments on raifing filk worms in England, had found that the filk worm could with fafety be kept on lettuce for fome time. This is pretty generally known by ladies who have turned their attention to this fubject; but fhe found that in general they could not with fafety be kept upon that food above three weeks. If longer fed upon that plant, the worms for the moft part die without fpinning a web at all. She found, however, that they did not always die, but that in fome cafes they produced very good cocoons, even when fed entirely on lettuce. She therefore with reafon fufpected that the death of the animal muft be occafioned by fome extraneous circumftance, and not from the poifonous quality of the food itfelf; the circumftance fhe fufpected, from fome incidental obfervations, was the coldnefs of that food; and therefore fhe thought it was not impoffible, but if they were kept in a very warm place, while fed on lettuce, they might attain, in all cafes, a due perfection.

13 General Mordaunt ftill more fuccefsful.

General Mordaunt having been informed of this conjecture, refolved to try the experiment. He got fome filk worms eggs, had them hatched in his hot-houfe, and caufed them to be all fed upon lettuce and nothing elfe. They profpered as well as any worms could do, few or none of them died; and they afforded as fine cocoons as if they had been fed upon mulberry leaves. As far as one experiment can go, this affords a very exhilarating profpect in many points of view. If one kind of food has been noxious, merely on account of an improper temperature, others may be found which have been hurtful only from a fimilar caufe; fo that it is not impoffible but we may at laft find that this delicate creature may be fupported by a variety of kinds of food. Few, however, could be more eafily obtained than lettuce; and this plant, when cabbaged (the cofs, or ice lettuce efpecially), would poffefs one quality that the mulberry leaf never can poffefs, from the want of which many millions of worms die in thofe countries where filk is now reared; for it is obferved, that when the leaves are gathered wet, it is fcarcely poffible to preferve the worms alive for any length of time; fo that during a continuance of rainy weather many of them are unavoidably cut off; but a lettuce, when cabbaged, refifts moifture. If gathered, even during rain, the heart of it is dry; fo that if the outer leaves be thrown afide at that time, the worms would be continued in perfect health. The expence, too, of cultivating and gathering lettuce, would be fo much lefs than that of gathering mulberry leaves, as to occafion a faving that would be much more than fufficient to counterbalance the expence of heating the confervatory, as a little reflection will fhow.

But the great point to be now afcertained is, whether it is a fact that worms fed on lettuce, if kept in a due temperature, will continue in good health, in general, till they fhall have perfected their cocoon? One experiment is too little to eftablifh this fact with perfect certainty. It would therefore be neceffary that more experiments fhould be made on this fubject.

14 Silk worms faid to be fed on dried mulberry leaves.

It is faid that Dr Lodovico Bellardi, a learned and ingenious botanift of Turin, has, after a number of experiments, difcovered a new method of feeding filk worms, when they are hatched before the mulberry trees have produced leaves, or when it happens that the froft deftroys the tender branches. This new method confifts in giving the worms dried leaves of the mulberry-tree, One would think that this dry nourifhment would not be much relifhed by thefe infects; but repeated experiments made by our author, prove that they prefer it to any other, and eat it with the greateft avidity. The mulberry leaves muft be gathered about the end of autumn, before the frofts commence, in dry weather, and at times when the heat is greateft. They muft be dried afterwards in the fun, by fpreading them upon large cloths, and laid up in a dry place after they have been reduced to powder. When it is neceffary to give this powder to the worms, it fhould be gently moiftened with a little water, and a thin coat of it muft be placed around the young worms, which will immediately begin to feed upon it.

15 Proper experiments ought to be made on various vegetables.

We have mentioned all the different kinds of food, which, as far as we have heard, have been tried with any fuccefs to nourifh the filk worm; not, however, with great confidence, but as experiments which it might be worth while carefully to confider and perform. We muft not omit to mention that one perfon, who has had much

(B) It is not improbable, fays Dr Anderfon, to whofe valuable work entitled the *Bee*, we have been much indebted in the drawing up of this article, that other kinds of food may be found which will anfwer the fame purpofe. The chicorium intybus and common endive might be tried, as they have the fame lactefcent quality with the lettuce.

Silk. much experience in the managing of silk worms, assures us, that the silk produced from any other food than mulberry leaves is of an inferior quality, and that the worms are sickly. We think, however, that there is reason to suspect that the experiment has not been skilfully performed; and therefore, before every other food except mulberry leaves is discarded, the experiment ought to be performed with more attention and care. We know that many animals in a domestic state can live upon food very different from that which supported them when running wild in the fields. Certain it is, however, that every animal, in its state of nature, partakes of a food peculiar to itself, which is rejected by other animals as if it were of a poisonous quality; and it may be mentioned as a curious fact, as well as an admirable instance of the care of that Being who feeds the fowls of heaven, that notwithstanding the numberless insects that prey upon animals and vegetables, the mulberry tree is left untouched by them all, as the exclusive property of the silk worm, the chief of the insect tribe, which toils and spins for the use of man.

16 What situation and apartments proper for these insects.

Having now considered the food proper for the silk worm, we shall next consider what situation is most favourable to them. In the opinion of some persons in this country who have been in the practice of rearing silk worms, they ought always to be kept in a dry place, well sheltered, and possessing a considerable degree of warmth, and which is not exposed to sudden transitions from heat to cold. If the weather be too cold, a small fire must be made: this is of most importance when the worms are ready for spinning. A southern exposure is therefore preferable. Some think light is of great utility to silk worms, others think that they thrive better in the dark. As to what apartments are best accommodated for promoting the health of silk worms, and most convenient for those who have the care of them, they may be various according to the extent of the manufacture or the wealth of the proprietors. Silk worms may be kept in boxes or in shelves. When shelves are to be used, they may be constructed in the following manner: The shelves may be of wicker, ranged at the distance of a foot and a half, and fixed in the middle of the room: their breadth ought to be such, that any person can easily reach to the middle from either side. This is perhaps the simplest and cheapest apparatus for rearing silk worms; but there is another apparatus which may be recommended to those who are anxious to unite some degree of elegance with convenience. This apparatus is the invention of the Rev. George Swayne of Puckle-church, a gentleman who has studied this subject much, in order to find out the way for promoting the culture of silk among the poor. This apparatus, with the description of it, may be found in the Transactions of the Society for encouraging Arts, Manufactures, and Commerce, vol. vii. p. 148.

17 Mr Swayne's apparatus described.

The apparatus consists of a wooden frame four feet two inches high, each side 16 inches and a half wide, divided into eight partitions by small pieces of wood which form grooves, into which the slides run, and are thus easily thrust into or drawn out of the frame. The upper slide in the model sent to the society by Mr Swayne is of paper only, and designed to receive the worms as soon as hatched; the two next are of catgut, the threads about one-tenth of an inch distant from each other: these are for the insects when a little advanced in size: the five lower ones are of wicker work; but, as Mr Swayne afterwards found, netting may be substituted with advantage instead of wicker bottoms. Under each of these, as well as under those of catgut, are sliders made of paper, to prevent the dung of the worms from falling on those feeding below them.

18 Proper time for hatching silk worms.

The management of silk worms is next to be attended to. The proper time for hatching them is when the leaves of the mulberry are full grown, or nearly so; that as soon as these insects are capable of receiving food they may obtain it in abundance. To attempt to hatch them sooner would be hurtful, as the weather would not be sufficiently warm. Besides, as leaves are necessary to the life of a vegetable, if the young leaves of the mulberry tree are cropped as soon as they are unfolded, the tree will be so much weakened as to be incapable of producing so many leaves as it would otherwise have done; and if this practice be frequently repeated, will inevitably be destroyed.

19 How they ought to be hatched and fed.

When the proper season is arrived, the eggs may be hatched either by the heat of the sun, when it happens to be strong enough, or by placing them in a small room moderately heated by a stove or fire; and after being exposed for six or seven days to a gentle heat, the silk worm issues from the egg in the form of a small black hairy caterpillar. When Mr Swayne's apparatus is used, the worms are to be kept on the drawers with paper bottoms till they are grown so large as not readily to creep through the gauze-bottomed drawers: they are then to be placed on those drawers, where they are to remain till their excrements are so large as not readily to fall through; when this is the case, they must be removed to the drawers with the wicker or netting bottoms, and fed thereon, till they show symptoms of being about to spin. It is scarcely necessary to mention, that the paper slides beneath the gauze and wicker drawers are intended to receive the dung, which should be emptied as often as the worms are fed, at least once a-day; or to direct, that when the worms are fed, the slides are to be first drawn out a considerable way, and the drawers to rest upon them.

20 Wet or damp food produces contagious diseases.

It has been already mentioned, that wet or damp food is exceedingly prejudicial to those insects. It produces contagious and fatal diseases. To prevent the necessity of giving them wet or damp food, attention ought to be paid to the weather, so that when there is an immediate prospect of rain, a sufficient quantity of leaves may be gathered to serve the worms two or three days. In this country, the leaves of the black or red mulberry tree may be preserved good for food, although kept four or five days, by the following method: When new gathered, lay them loosely in glazed earthen vessels, place these in a cold place, well aired, not exposed to drought.

21 Ought to be kept as clean as possible.

The utmost attention must be paid to preserve the place where silk worms are kept as clean as possible: the house or room must be well ventilated, that no noxious vapours be accumulated. By some experiments of M. Faujas de St Fond, which are recorded in his history of Languedoc, it appears that the silk worm is much injured by foul air. All decayed leaves must be removed from them, as it is now well known that they emit bad air in great abundance

One of the most difficult branches of the management of silk worms has hitherto been the cleaning without bruising

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bruifing them. To avoid this inconvenience, the peafants in France and Italy frequently allow the whole litter to remain without ever cleaning them, which is the caufe of that unwholefome ftench that has been fo often remarked by thofe who vifit the places for rearing filk worms in thefe countries.

22 How they may be cleaned without bruifing them.

This difficulty may be effectually removed by providing a net, or, what would be ftill better, a wire-bottomed frame, wrought into large mefhes like a riddle. Have that made of a fize exactly fufficient to cover the wooden box in which the worms are kept. When you mean to fhift them, fpread frefh leaves into the wire bafket; and let it down gently over the worms till it comes within their reach. They no fooner perceive the frefh food than they abandon the rubbifh below, and creep through the mefhes, fo as to fix themfelves upon the leaves; then by gently raifing the frefh bafket, and drawing out the board below (which ought to be made to flip out like the flip-bottom of a bird's cage), you get off all the excrements and decayed leaves, without incommoding the worms in the fmalleft degree; and along with the litter you will draw off an inch or two in depth of the fouleft mephitic vapours. To get entirely rid of thefe, the board, when thus taken out, fhould be carried without doors, and there cleaned; and the flip-board immediately replaced to receive all the excrements and offals. After it is replaced, the wire frame that had been elevated a little, may be allowed to defcend to a convenient diftance above the board without touching it. Thus will there be left a vacant fpace for the mephitic air to fall below the worms, fo as to allow them to inhabit a wholefome region of the atmofphere.

When a frefh fupply of food is to be given before cleaning, the wire frame ought to be let down as clofe to the board as can be fafely done, and another wire-bottomed frame put over it, with frefh leaves, as before defcribed. When the worms have abandoned that in their turn, let the flip-board, together with the lower wire frame, be drawn out and removed, and fo on as often as neceffary. To admit of this alternate change, every table, confifting of one flip-board, ought to have two fets of wire-bottomed frames of the fame fize; the flip-board to be always put into its place immediately after it is cleaned, and the wire frames referved to be afterwards placed over the other. By this mode of management, it is probable that the worms would be faved from the difeafes engendered by the mephitic air, and the numerous deaths that are the confequence of it avoided.

23 Quicklime would abforb all the bad air which furrounds them.

Dr Anderfon, to whom we have already acknowledged our obligations, and to whom this country has been much indebted for valuable works on agriculture, the fifheries, &c. advifes thofe who have the management of filk worms to ftrew a thin ftratum of frefh flaked quicklime upon the flip-board each time it is cleaned, immediately before it is put into its place. This would abforb the mephitic gas, for as foon as it is generated it would defcend upon the furface of the quicklime. Thus would the worms be kept continually in an atmofphere of pure air (c). Were the walls of the apartments to be frequently wafhed with quicklime and water, it would tend much to promote cleanlinefs at a fmall expence, and augment the healthinefs of the worms as well as that of the perfons who attend them.

24 Mr Swayne's receptacle for the worms, when going to fpin.

Tranfactions of the Society for the Encouragement of Arts, vol. viii. p. 123.

When the filk worm refufes its food, and leaves filky traces on the leaves over which it paffes, it is a proof that it is ready to begin its cocoon. It is now neceffary to form a new receptacle, which is commonly done by pinning together papers in the fhape of inverted cones with broad bafes. "This method (fays Mr Swayne), where there are many worms, is exceedingly tedious, waftes much paper, and ufes a large number of pins; befides, as the filk worm always weaves an outer covering or defenfive web before it begins the cocoon or oval ball, I apprehended that it caufed a needlefs wafte of filk in forming the broad web at the top. The method I make ufe of is, to roll a fmall piece of paper (an uncut octavo leaf, fuch as that of an old magazine, is fufficient for three), round my fore-finger, and to give it a twift at the bottom; which is done with the utmoft expedition, and gives no occafion for the ufe of pins. Thefe rolled paper-cafes being likewife of a form more nearly refembling that of a cocoon, with a much narrower opening on the top than the others, takes away the neceffity of wafting much filk in the outer web, and confequently leaves more to be employed in forming the ball. The filk is readily taken out of thefe cafes by untwifting the bottom; and if this be done with moderate care, and the papers are preferved, they will ferve feveral times for the like purpofe."

25 Others recommend bufhes of heath.

Others advife, that when the filk worms are preparing to fpin, little bufhes of heath, broom, or twigs, fhould be

(c) To put this queftion beyond a doubt, Mr Blancard made the following comparative experiments, which were feveral times repeated. "I procured (fays he) four glafs jars nine inches high and five in diameter, clofing the mouth with cork ftoppers. After which I placed in each of them, in their fecond life (fo *mue* may be tranflated, which means the ftage between the different fickneffes), twelve filk worms, which were fed four times a-day; and which I confined in this kind of prifon all their life, without taking away either their dead companions or their ordure or litter. I fprinkled with chalk the worms of only two of thefe jars, and kept the two others to compare with them.

"In thofe without lime, I never obtained either more or lefs than three fmall and imperfect cocoons (*chiques ou bouffard*), and in the two that were fprinkled with lime, I had very often twelve, and never lefs than nine fine full-fized firm cocoons."

This experiment affords the moft fatisfactory proof of the utility of this procefs. From a number of trials he found, that even when the worms were covered with a large proportion of lime, they never were in any way incommoded by it.

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be ſtuck upright near the ſhelf or box in which they are incloſed: the worms mount theſe, and attach their web to them.

26
How ſilk worms may be revived when affected by thunder.
Tranſactions of the American Philoſophical Society, vol. ii.

When the worms are ready to mount, in order to ſpin, if the weather be hot, attended with thunder, you will ſee them in a languiſhing condition; your care muſt then be to revive them, which is effected thus: Take a few eggs and onions, and fry them in a pan with ſome ſtale hog's lard, the ranker the better, and make pancake; which done, carry it ſmoaking hot into the room where they are kept, and go round the chamber with it. You will be ſurpriſed to ſee how the ſmell revives them, excites thoſe to eat who have not done feeding, and makes the others that are ready to ſpin climb up the twigs.

27
Different kinds of cocoons.

In about ten or twelve days, according to the accounts which we have received from Mr Andrew Wright of Paiſley, it may be ſafely concluded, that if the worms have finiſhed their work, the cocoons may be collected.

We ſhall now diſtinguiſh the cocoons from one another according to their value or their uſe, and conſider the method of managing each. They may be diſtinguiſhed into the good and bad. The good cocoons may be known by theſe marks: they are little, ſtrong, and firm; have a fine grain, both ends are round, and they are free from ſpots. Among the good cocoons alſo may be arranged thoſe which are called *calcined* cocoons, in which the worm, in conſequence of ſickneſs, is petrified or reduced to a fine powder. Theſe cocoons produce more ſilk than others, and are ſold in Piedmont at half as much again. They may be diſtinguiſhed by the noiſe which the worm makes when the cocoon is ſhaken. Of the bad cocoons there are ſix ſpecies: 1. The *pointed cocoons*, one extremity of which ends in a point; the ſilk which covers the point is weak, and ſoon breaks or tears. 2. The *cocalons*, which are bigger, but the contexture is weak. 3. The *dupions*, or double cocoons, which have been formed by the joint labour of two and ſometimes of three worms. 4. The *ſoufflons*, which have a looſe contexture, ſometimes ſo looſe that they are tranſparent. 5. The *perforated cocoons*, which have a hole at one end. 6. The *bad choquette*, which is compoſed of defective cocoons, ſpotted or rotten. Beſides theſe there is the *good choquette*, which does not properly belong to either of theſe two claſſes: it is formed of thoſe cocoons in which the worm dies before the ſilk is brought to perfection. The worms adhere to one ſide of the cocoon, and therefore when the cocoon is ſhaken will not rattle: the ſilk is as fine, but is not of ſo bright a colour, nor is ſo ſtrong and nervous, as that which is obtained from good cocoons.

28
Mr Wright's inſtructions for ſelecting and preſerving the royal cocoons.

The cocoons which are kept for breeding are called *royal* cocoons. For ſelecting and preſerving theſe, we have been favoured with ſome valuable inſtructions by Mr Wright of Paiſley, which we ſhall preſent to our readers.—The largeſt and beſt cocoons ought to be kept for breed, about an equal number of males and females; the cocoons that contain the former are ſharper pointed at the ends than thoſe that contain the latter. Although it ſhould happen that there are more females than males, little inconvenience or ill conſequences can ariſe from it, as one male will ſerve two or three females, if the time of their coming out of the cocoons anſwer. About 12 or 15 days after they begin to ſpin, the cocoons for breed may be laid on ſheets of white paper; about this time the moth opens for itſelf a paſſage through the end of its cocoon, and iſſues out. When the female has laid her eggs, which on an average may amount to 250, they are ſpread upon ſheets of paper and hung up to dry in ſome place where they may not be expoſed to the heat of the ſun: after being dried they muſt be kept in a cool well-aired place, where neither vapours nor moiſture can reach them. That they may be preſerved from external accidents, as inſects of different kinds will deſtroy them, and mice is their enemy in all the ſtages of their exiſtence, they ſhould be kept in ſtone pots or glaſs bottles with their mouths ſtopped, and there remain until brought out next ſeaſon to be hatched.

29
How to prepare the cocoons for being wound.
Tranſactions of the American Philoſophical Society, vol. ii.

The cocoons from which the ſilk is to be immediately wound muſt be expoſed to the heat of an oven, in order to kill the chryſalis or aurelia, which would otherwiſe eat its way through the cocoon, and render it uſeleſs. The following directions are given for managing this proceſs by one of the firſt ſilk manufactures in Italy.

Put your cocoons in long ſhallow baſkets, and fill them within an inch of the top. You then cover them up with paper, and put a wrapper over that. Theſe baſkets are to be diſpoſed in an oven, whoſe heat is as near as can be that of an oven from which the bread is juſt drawn after being baked. When your cocoons have remained therein near an hour, you muſt draw them out; and to ſee whether all the worms are dead, draw out a dupion from the middle of your baſket and open it: if the worm be dead, you may conclude all the reſt are ſo; becauſe the contexture of the dupion being ſtronger than that of the other cocoons, it is conſequently leſs eaſy to be penetrated by the heat. You muſt obſerve to take it from the middle of the baſket, becauſe in that part the heat is leaſt perceptible. After you have drawn your baſkets from the oven, you muſt firſt cover each of them with a woollen blanket or rug, leaving the wrapper beſides, and then you pile them above one another. If your baking has ſucceeded, your woollen cover will be all over wet with a kind of dew, the thickneſs of your little finger. If there be leſs, it is a ſign your cocoons have been too much or too little baked. If too much baked, the worm, being over-dried, cannot tranſpire a humour he no longer contains, and your cocoon is then burnt. If not enough baked, the worm has not been ſufficiently penetrated by the heat to diſtil the liquor he contains, and in that caſe is not dead.

You muſt let your baſkets ſtand thus covered five or ſix hours if poſſible, in order to keep in the heat, as this makes an end of ſtifling thoſe worms which might have avoided the firſt impreſſion of the fire. You are likewiſe to take great care to let your cocoons ſtand in the oven the time that is neceſſary; for if they do not ſtand long enough, your worms are only ſtunned for a time and will afterwards be revived. If, on the other hand, you leave them too long in the oven, you burn them many inſtances of theſe two caſes are frequently to be met with. It is a good ſign when you ſee ſome of the butterflies flying out from the cocoons which have been baked, becauſe you may be certain they are not burnt. For if you would kill them all to the laſt worm, you would burn many cocoons which might be more expoſed to the heat than that particular worm.

The next operation is the winding of the ſilk. Before you begin to wind, you muſt prepare your cocoons as follows:

50 How the ſilk is to be wound from the cocoons.

1. In ſtripping them of that waſte ſilk that ſurrounds them, and which ſerved to faſten them to the twigs. This burr is proper to ſtuff quilts, or other ſuch uſes; you may likewiſe ſpin it to make ſtockings, but they will be coarſe and ordinary.

2. You muſt ſort your cocoons, ſeparating them into different claſſes in order to wind them apart. Theſe claſſes are, the good white cocoons; the good cocoons of all the other colours; the dupions; the cocalons, among which are included the weak cocoons; the good choquette; and, laſtly, the bad choquette. In ſorting the cocoons, you will always find ſome perforated cocoons amongſt them, whoſe worm is already born; thoſe you muſt ſet apart for fleuret. You will likewiſe find ſome ſoufflons, but very few; for which reaſon you may put them among the bad choquette, and they run up into waſte.

The good cocoons, as well white as yellow, are the eaſieſt to wind; thoſe which require the greateſt care and pains are the cocalons; you muſt wind them in cooler water than the others, and if you take care to give them to a good windſter, you will have as good ſilk from them as the reſt. You muſt likewiſe have careful windſters for the dupions and choquettes. Theſe two ſpecies require hotter water than the common cocoons.

The good cocoons are to be wound in the following manner: Firſt, chooſe an open convenient place for your filature, the longer the better, if you intend to have many furnaces and coppers. The building ſhould be high and open on one ſide, and walled on the other, as well to ſcreen you from the cold winds and receive the ſun, as to give a free paſſage to the ſteam of your baſons or coppers.

Theſe coppers or baſons are to be diſpoſed (when the building will admit of it) in a row on each ſide of the filature, as being the moſt convenient method of placing them, for by that means in walking up and down you ſee what every one is about. And theſe baſons ſhould be two and two together, with a chimney between every couple.

Having prepared your reels (which are turned by hands, and require a quick eye), and your fire being a light one under every baſon, your windſter muſt ſtay till the water is as hot as it can be without boiling. When every thing is ready, you throw into your baſons two or three handfuls of cacoons, which you gently bruſh over with a wiſk about ſix inches long, cut ſtumpy like a broom worn out: by theſe means the threads of the cocoons ſtick to the wiſk. You muſt diſengage theſe threads from the wiſk, and purge them by drawing theſe ends with your fingers till they come off entirely clean. This operation is called *la Battue.*

When the threads are quite clear, you muſt paſs four of them (if you will wind fine ſilk) through each of the holes in a thin iron bar that is placed horizontally at the edge of your baſon; afterwards you twiſt the two ends (which conſiſt of four cocoons each) twenty or twenty-five times, that the four ends in each thread may the better join together in croſſing each other, and that your ſilk may be plump, which otherwiſe would be flat.

Your windſter muſt always have a bowl of cold water by her, to dip her fingers in, and to ſprinkle very often the ſaid bar, that the heat may not burn the thread.

Your threads, when thus twiſted, go upon two iron hooks called rampins, which are placed higher, and from thence they go upon the reel. At one end of the axis of the reel is a cog-wheel, which catching in the teeth of the poſt-rampin, moves it from the right to the left, and conſequently the thread that is upon it; ſo that your ſilk is wound on the reel croſsways, and your threads form two hanks of about four fingers broad.

As often as the cocoons you wind are done, or break or diminiſh only, you muſt join freſh ones to keep up the number requiſite, or the proportion; becauſe, as the cocoons wind off, the thread being finer, you muſt join two cocoons half wound to replace a new one: Thus you may wind three new ones and two half wound, and your ſilk is from four to five cocoons.

When you would join a freſh thread, you muſt lay one end on your finger, which you throw lightly on the other threads that are winding, and it joins them immediately, and continues to go up with the reſt. You muſt not wind off your cocoons too bare or to the laſt, becauſe when they are near at an end, the *bairré*, that is, the huſk, joins in with the other threads, and makes the ſilk foul and gouty.

When you have finiſhed your firſt parcel, you muſt clean your baſons, taking out all the ſtriped worms, as well as the cocoons, on which there is a little ſilk, which you firſt open and take out the worm, and then throw them into a baſket by you, into which you likewiſe caſt the looſe ſilk that comes off in making the battue.

You then proceed as before with other two or three handfuls of cocoons; you make a new battue; you purge them, and continue to wind the ſame number of cocoons or their equivalent, and ſo to the end.

As was already mentioned, the windſter muſt always have a bowl of cold water by her, to ſprinkle the bar, to cool her fingers every time ſhe dips them in the hot water, and to pour into her baſon when neceſſary, that is, when her water begins to boil. You muſt be very careful to twiſt your threads a ſufficient number of times, about 25, otherwiſe your ſilk remains flat, inſtead of being round and full; beſides, when the ſilk is not well croſſed, it never can be clean, becauſe a gout or nub that comes from a cocoon will paſs through a ſmall number of theſe twiſts, though a greater will ſtop it. Your thread then breaks, and you paſs what foulneſs there may be in the middle of your reel between the two hanks, which ſerves for a head-band to tie them.

You muſt obſerve that your water be juſt in a proper degree of heat. When it is too hot, the thread is dead, and has no body; when it is too cold, the ends which form the thread do not join well, and form a harſh ill-qualified ſilk.

You muſt change the water in your baſon four times a day for your dupions and choquette, and twice only for good cocoons when you wind fine ſilk; but if you wind coarſe ſilk, it is neceſſary to change it three or four times. For if you were not to change the water, the ſilk would not be ſo bright and gloſſy, becauſe the worm contained

contained in the cocoons foul it very confiderably. You muft endeavour to wind as much as poffible with clear water, for if there are too many worms in it, your filk is covered with a kind of duft which attracts the moth, and deftroys your filk.

You may wind your filk of what fize you pleafe, from one cocoon to 1000; but it is difficult to wind more than 30 in a thread. The nicety, and that in which confifts the greateft difficulty, is to wind even; becaufe as the cocoon winds off the end is finer, and you muft then join other cocoons to keep up the fame fize. This difficulty of keeping the filk always even is fo great, that (excepting a thread of two cocoons, which we call fuch) we do not fay a filk of three, of four, or fix cocoons; but a filk of three to four, of four to five, of fix to feven cocoons. If you proceed to a coarfer filk, you cannot calculate fo nicely as to one cocoon more or lefs. We fay, for example, from 12 to 15, from 15 to 20, and fo on.

31 What number of worms produce a certain quantity of filk.

What number of worms are neceffary to produce a certain quantity of filk has not been afcertained. And as different perfons who wifhed to determine this point have had different refults, the truth feems to be, that from various circumftances the fame number of worms may produce more filk at one time than at another. It is related in the fecond volume of the Tranfactions of the Society for encouraging Arts, &c. that Mrs Williams obtained nearly an ounce and a half of filk from 244 cocoons. Mr Swayne from 50 cocoons procured 100 grains. Mifs Rhodes obtained, from 250 of the largeft cocoons, three quarters of an ounce and a dram. From a paper in the fecond volume of the American Tranfactions, which we have before referred to in the courfe of this article, we are informed that 150 ounces of good cocoons yield about 11 ounces of filk from five to fix cocoons: if you wind coarfer, fomething more. But what appears aftonifhing, Mr Salvatore Bertezen, an Italian, to whom the Society for encouraging Arts, &c adjudged their gold medal, raifed five pounds of excellent filk from 12,000 worms.

32 Length of the threads.

The cocoons produce a thread of very unequal length; you may meet with fome that yield 1200 ells, whilft others will fcarcely afford 200 ells. In general, you may calculate the production of a cocoon from 500 to 600 ells in length.

SILK-Loom. See WEAVING.

SILK Worm. See SILK.

SILLA, a large town on the Niger, by which the travels of Mr Park were bounded towards the eaft. He gives no particular defcription of the place, which his health and fpirits permitted him not to furvey, but affigns the reafons by which he was induced to proceed no farther. On his arrival, he was allowed to remain under a tree, till it was quite dark, furrounded by hundreds of people. But their language was extremely different from the other parts of Bambarra; and he was given to underftand, that in his progrefs eaftward, the Bambarra tongue was very little underftood; and that, on his reaching Jenné, he would find the greater part of the inhabitants accuftomed to fpeak a different language. He had now become the prey of ficknefs, exhaufted with hunger and fatigue, half naked, and without any article of value, to procure for himfelf provifions, clothes, or lodging, on which account he refolved to return, finding that to profecute his journey further in that direction was wholly impracticable. Silla, according to the lateft map of Africa, is in 14° 48′ N. Lat. and 1° 24′ W. Long.

SILPHA, CARRION-BEETLE, a genus of infects belonging to the order *coleoptera*. See ENTOMOLOGY *Index*.

SILPHIUM, a genus of plants belonging to the clafs of fyngenefia, and to the order of polygamia neceffaria; and in the natural fyftem arranged under the 49th order, *compofitæ*. See BOTANY *Index*.

SILVER, a well known metallic fubftance. For an account of its properties, fee CHEMISTRY *Index*.

SILVER, Ores of. See MINERALOGY *Index*.

Shell-SILVER, is prepared of the fhreds of filver leaf, or of the leaves themfelves, for the ufe of painters, after the fame manner as fhell gold. See *Shell GOLD*.

SILVERING, the covering of any thing with filver. It is ufual to filver metals, wood, paper, &c. which is performed either with fire, oil, or fize. Metal-gilders filver by the fire; painter gilders all the other ways. See GILDING.

To filver copper or brafs. 1. Cleanfe the metal with aquafortis, by wafhing it lightly, and immediately throwing it into pure water; or by heating it red-hot, and fcouring it with falt and tartar, and pure water, with a fmall wire brufh. 2. Diffolve fome filver in aquafortis, in a broad-bottomed glafs veffel, or of glazed earth; then evaporate away the aquafortis over a chaffing difh of coals. 3. Put five or fix times its quantity of water, or as much as will be neceffary to diffolve it perfectly, on the remaining dry calx; evaporate this water with the like heat; then put more frefh water, and evaporate again; and, if need be, the third time, making the fire towards the latter end fo ftrong as to leave the calx perfectly dry, which, if your filver is good, will be of a pure white. 4. Take of this calx, common falt, cryftals of tartar, of each a like quantity or bulk, and mixing well the whole compofition, put the metal into pure water, and take of the faid powder with your wet fingers, and rub it well on, till you find every little cavity of the metal fufficiently filvered over. 5. If you would have it richly done, you muft rub on more of the powder; and, in the laft place, wafh the filvered metal in pure water, and rub it hard with a dry cloth.

SILVERING of Glaffes. See *FOLIATING of Looking-glaffes*.

SILURIS, a genus of fifhes belonging to the order abdominales. See ICHTHYOLOGY *Index*.

SIMANCAS, a village on the eaftern boundary of the kingdom of Leon in Spain, fix miles below Valladolid, on the river Gifnerga. Dr Robertfon, in the introduction to his Hiftory of America, makes mention of it, and it is remarkable for the archives of the kingdoms of Leon and Caftile, kept in the caftle. This collection was begun when the kings often refided at Valladolid, in which city is ftill the civil and military tribunal for almoft the whole of Spain to the north of the Tagus. It was thought proper to have thofe papers kept in the vicinity of that court, for which purpofe this caftle was peculiarly fitted, being entirely erected of ftone. At one period there were two large halls in this office filled with papers refpecting the firft fettlement of the Spaniards in South America. There was likewife in the room called the *ancient royal patronage*, a box containing

containing treaties with England, in which are many letters and treaties between the kings of England and Spain, from the year 1400 to 1600. There was alfo a ftrong box in the fame archives, with five locks, which, we are told, has not been opened fince the time of Philip II. and it is fuppofed that it contains the procefs againft Philip's fon Prince Charles. But it appears that fome of the ftate papers have been removed to Madrid.

SIMEON *of Durham*, the cotemporary of William of Malmfbury, took great pains in collecting the monuments of our hiftory, efpecially in the north of England, after they had been fcattered by the Danes. From thefe he compofed a hiftory of the kings of England, from A. D. 616 to 1130; with fome fmaller hiftorical pieces. Simeon both ftudied and taught the fciences, and particularly the mathematics at Oxford; and became precentor of the church at Durham, where he died, probably foon after the conclufion of his hiftory, which was continued by John, prior of Hexham, to A. D. 1156.

SIMIA, the Monkey, a genus of quadrupeds belonging to the clafs of mammalia, and order of primates, in the Linnæean fyftem, but by Mr Pennant arranged under the digitated quadrupeds. See Mammalia *Index*.

SIMILE, or Similitude, in *Rhetoric*, a comparifon of two things, which though different in other refpects, yet agree in fome one. The difference between a fimile and comparifon is faid to confift in this, that the fimile properly belongs to whatever we call the quality of a thing, and the comparifon to the quantity. See Comparison; and Oratory, N° 118.

SIMILOR, a name given to an alloy of red copper and zinc, made in the beft proportions, to imitate filver and gold.

SIMON Maccaceus, a celebrated leader and highprieft of the Jews, who, after rendering the moft important fervices to his country, was at laft treacheroufly flain by his fon-in-law. See *the Hiftory of the Jews*, N° 15.

Simon Magus, or the Sorcerer, was a native of Gitton, a village of Samaria. According to the ufual practice of the Afiatics of that age, he vifited Egypt, and there probably became acquainted with the fublime myfteries taught in the Alexandrian fchool, and learned thofe theurgic or magical operations, by means of which it was believed that men might be delivered from the power of evil demons. Upon his return into his own country, the author of the Clementine Recognitions relates, that he impofed upon his countrymen by high pretenfions to fupernatural powers. And St Luke attefts, that this artful fanatic, ufing forcery, had bewitched the people of Samaria, giving out that he was *fome great one*; and that he obtained fuch general attention and reverence in Samaria, that the people all gave heed to him from the leaft to the greateft, faying, "This man is the great power of God."

Enfield's Hiftory of Philofophy, vol. ii. p. 161.

By the preaching of Philip the Deacon, he was with other Samaritans converted to the Chriftian faith, and admitted into the infant church by the ordinance of baptifm. His converfion, however, feems not to have been real; for, upon feeing the miraculous effects of the laying on of the apoftle's hands, he offered them money, faying, "Give me alfo this power, that on whomfoever I lay hands he may receive the Holy Ghoft." He probably thought Peter and John magicians like himfelf, but better fkilled in the art of deceiving the multitude.

Being fharply reproved for this impiety, he feems by his anfwer to have been made fenfible of his fin; but his repentance, if fincere, was of fhort duration. Returning to his former practices of impofture, he travelled through various provinces of the empire, oppofing the progrefs of the gofpel; and arriving at Rome, he led aftray vaft numbers of people by his pretended miracles. How long he lived in that metropolis of the world, or in what manner he died, we have no accounts that can be fully depended on. The Chriftian writers tell us, that being raifed in the air by two dæmons, he was deprived of their fupport by the prayers of St Peter and St Paul, and falling, broke his legs. By fome he is thought to have been the perfon mentioned by Suetonius, who, undertaking to fly in the prefence of Nero, fell to the ground with fuch violence, that his blood fpurted up to the gallery where the emperor was fitting,

The fum of this impoftor's doctrine, divefted of allegory, was, that from the Divine Being, as a fountain of light, flow various orders of æons, or eternal natures, fubfifting within the plenitude of the divine effence; that beyond thefe, in the order of emanation, are different claffes of intelligences, among the loweft of which are human fouls; that matter is the moft remote production of the emanative power, which, on account of its infinite diftance from the Fountain of Light, poffeffes fluggifh and malignant qualities, which oppofe the divine operations, and are the caufe of evil; that it is the great defign of philofophy to deliver the foul from its imprifonment in matter, and reftore it to that divine light from which it was derived; and that for this purpofe God had fent him one of the firft æons among men. To his wife Helena he alfo afcribed a fimilar kind of divine nature, pretending that a female æon inhabited the body of this woman, to whom he gave the name of Εννοια, *Wifdom*; whence fome Chriftian fathers have faid, that he called her the *Holy Spirit*. He alfo taught the tranfmigration of fouls, and denied the refurrection of the body.

Simon, *Richard*, was born at Dieppe the 15th May 1638. He began his ftudies among the priefts of the Oratory in that city, but quitted their fociety in a fhort time. From Dieppe he went to Paris, where he made great progrefs in the ftudy of the oriental languages. Some time afterwards he joined the fociety of the Oratory again, and became a prieft of it in 1660. In 1670 he publifhed fome pieces of a fmaller kind. In 1678 his Critical Hiftory of the Old Teftament appeared, but was immediately fuppreffed by the intrigues of Meffieurs du Port Royal. It was reprinted the year after, and its excellence foon drew the attention of foreigners; an edition of it was accordingly publifhed at Amfterdam in Latin, and at London in Englifh.

He died at Dieppe in 1712, at the age of 74.

He certainly poffeffed a vaft deal of learning: his criticifm is exact, but not always moderate; and there reigns in his writings a fpirit of novelty and fingularity which raifed him a great many adverfaries. The moft celebrated of thefe were Le Clerc, Voffius, Jurieu, Du Pin, and Boffuet. Simon wrote an anfwer to moft of the

the books that were publifhed againft him, and difplays a pride and obftinacy in his controverfial writings which do him little honour.

He was the author of a great many books. The following are the principal: 1. The Ceremonies of the Jews, tranflated from the Italian of Leo of Modena, with a fupplement concerning the fects of the Carraites and Samaritans. 2. *L'Hiftoire Critique du Vieux Teftament*, "The Critical Hiftory of the Old Teftament." This is a very important work, and deferves the attention of every clergyman. He fometimes, however, deviates from the road of integrity, to ferve the caufe of the church of Rome, particularly in his endeavours to prove the uncertainty of the Hebrew language. Thefe paffages have been very juftly expofed and confuted by Dr Campbell, in his ingenious Preliminary Differtations to his new Tranflation of the Gofpels. 3. Critical Hiftory of the Text of the New Teftament. 4. Critical Hiftory of the Verfions of the New Teftament. 5. Critical Hiftory of the principal Commentators on the New Teftament. 6. Infpiration of the Sacred Books. 7. A tranflation of the New Teftament. This book was cenfured by Cardinal Noailles and Boffuet. 8. The Hiftory of the rife and progrefs of Ecclefiaftical Revenues, which is commended by Voltaire, as is his Critical Hiftory of the Old Teftament. It refulted from a quarrel with a community of Benedictines. 9. A new felect Library, which points out the good books in various kinds of literature, and the ufe to be made of them. 10. Critical Hiftory of the Belief and Cuftoms of the Nations on the Levant. 11. Critical Letters, &c.

SIMONICAL, is applied to any perfon guilty of fimony. See SIMONY.

SIMONIDES, the name of feveral poets celebrated in antiquity; but by the Marbles it appears that the eldeft and moft illuftrious of them was born in the 55th Olympiad, 538 years B. C. and that he died in his 90th year; which nearly agrees with the chronology of Eufebius. He was a native of Ceos, one of the Cyclades, in the neighbourhood of Attica, and the preceptor of Pindar. Both Plato and Cicero give him the character not only of a good poet and mufician, but fpeak of him as a perfon of great virtue and wifdom. Such longevity gave him an opportunity of knowing a great number of the firft characters in antiquity with whom he was in fome meafure connected. It appears in Fabricius, from ancient authority, that Simonides was cotemporary and in friendfhip with Pittacus of Mitylene, Hipparchus tyrant of Athens, Paufanias king of Sparta, Hiero tyrant of Syracufe, with Themiftocles, and with Alevades king of Theffaly. He is mentioned by Herodotus; and Xenophon, in his Dialogue upon Tyranny, makes him one of the interlocutors with Hiero king of Syracufe. Cicero alleges, what has often been quoted in proof of the modefty and wifdom of Simonides, that when Hiero afked him for a definition of God, the poet required a whole day to meditate on fo important a queftion: at the end of which, upon the prince putting the fame queftion to him a fecond time, he afked two days refpite; and in this manner always doubled the delay each time he was required to anfwer it; till at length, to avoid offending his patron by more difappointments, he frankly confeffed that he found the queftion fo difficult, that the more he meditated upon it, the lefs was his hope of being able to folve it.

In his old age, perhaps from feeing the refpect which money procured to fuch as had loft the charms of youth and the power of attaching mankind by other means, he became fomewhat mercenary and avaricious. He was frequently employed by the victors at the games to write panegyrics and odes in their praife, before his pupil Pindar had exercifed his talents in their behalf: but Simonides would never gratify their vanity in this particular, till he had firft tied them down to a ftipulated fum for his trouble; and upon being upbraided for his meannefs, he faid, that he had two coffers, in one of which he had for many years put his pecuniary rewards; the other was for honours, verbal thanks, and promifes; that the firft was pretty well filled, but the laft remained always empty. And he made no fcruple to confefs, in his old age, that of all the enjoyments of life, the love of money was the only one of which time had not deprived him.

He was frequently reproached for this vice; however, he always defended himfelf with good humour. Upon being afked by Hiero's queen, Whether it was moft defirable to be learned or rich? he anfwered, that it was far better to be rich; for the learned were always dependent on the rich, and waiting at their doors; whereas, he never faw rich men at the doors of the learned. When he was accufed of being fo fordid as to fell part of the provifions with which his table was furnifhed by Hiero, he faid he had done it in order "to difplay to the world the magnificence of that prince and his own frugality." To others he faid, that his reafon for accumulating wealth was, that "he would rather leave money to his enemies after death, than be troublefome to his friends while living."

He obtained the prize in poetry at the public games when he was fourfcore years of age. According to Suidas, he added four letters to the Greek alphabet; and Pliny affigns to him the eighth ftring of the lyre; but thefe claims are difputed by the learned.

His poetry was fo tender and plaintive, that he acquired the cognomen of *Melicertes*, "fweet as honey;" and the tearful eye of his mufe was proverbial. Dionyfius places him among thofe polifhed writers who excel in a fmooth volubility, and flow on like plenteous and perennial rivers, in a courfe of even and uninterrupted harmony.

It is to Dionyfius that we are indebted for the prefervation of the following fragment of this poet. Danae being by her mercilefs father inclofed in a cheft, and thrown into the fea with her child, when night comes on, and a ftorm arifes which threatens to overfet the cheft, fhe, weeping and embracing the young Perfeus, cries out:

Sweet child! what anguifh does thy mother know,
Ere cruel grief has taught thy tears to flow!
Amidft the roaring wind's tremendous found,
Which threats deftruction as it howls around;
In balmy fleep thou lieft, as at the breaft,
Without one bitter thought to break thy reft.——
The glimm'ring moon in pity hides her light,
And fhrinks with horror at the ghaftly fight.
Didft thou but know, fweet innocent! our woes,
Not opiate's pow'r thy eyelids now could clofe.

Sleep

Sleep on, ſweet babe! ye waves in ſilence roll;
And lull, O lull, to reſt my tortur'd ſoul!

There is a ſecond great poet of the name of Simonides recorded on the Marbles, ſuppoſed to have been his grandſon, and who gained, in 478 B. C. the prize in the games at Athens.

SIMONY, is the corrupt preſentation of any one to an eccleſiaſtical benefice for money, gift, or reward. It is ſo called from the reſemblance it is ſaid to bear o the ſin of Simon Magus, though the purchaſing of holy orders ſeems to approach nearer to his offence. It was by the canon law a very grievous crime: and is ſo much the more odious, becauſe, as Sir Edward Coke obſerves, it is ever accompanied with perjury; for the preſentee is ſworn to have committed no ſimony. However, it was not an offence puniſhable in a criminal way at the common law: it being thought ſufficient to leave the clerk to eccleſiaſtical cenſures. But as theſe did not affect the ſimoniacal patron, nor were efficacious enough to repel the notorious practice of the thing, divers acts of parliament have been made to reſtrain it by means of civil forfeitures; which the modern prevailing uſage, with regard to ſpiritual preferments, calls aloud to be put in execution. The ſtatute 31 Eliz. c. 6. enacts, that if any patron, for money or any other corrupt conſideration or promiſe, directly or indirectly given, ſhall preſent, admit, inſtitute, induct, inſtall, or collate any perſon to an eccleſiaſtical benefice or dignity, both the giver and taker ſhall forfeit two years value of the benefice or dignity; one moiety to the king, and the other to any one who will ſue for the ſame. If perſons alſo corruptly reſign or exchange their benefices, both the giver and taker ſhall in like manner forfeit double the value of the money or other corrupt conſideration. And perſons who ſhall corruptly ordain or licenſe any miniſter, or procure him to be ordained or licenſed (which is the true idea of ſimony), ſhall incur a like forfeiture of forty pounds; and the miniſter himſelf of ten pounds, beſides an incapacity to hold any eccleſiaſtical preferment for ſeven years afterwards. Corrupt elections and reſignations in colleges, hoſpitals, and other eleemoſynary corporations, are alſo puniſhed, by the ſame ſtatute, with forfeiture of the double value, vacating the place or office, and a devolution of the right of election, for that turn, to the crown.

SIMOOM, a hot wind which blows occaſionally in the deſerts of Africa, and probably in other widely extended countries parched in the ſame manner by a vertical ſun. Its effects on the human body are dreadful. If inhaled in any quantity, it produces inſtant ſuffocation, or at leaſt leaves the unhappy ſufferer oppreſſed with aſthma and lowneſs of ſpirits. The approach of this awful ſcourge of God is indicated by a redneſs in the air, well underſtood by thoſe who are accuſtomed to journey through the deſert; and the only refuge which they have from it, is to fall down with their faces cloſe to the ground, and to continue as long as poſſible without drawing in their breath.

Bruce's Travels, vol. iv. p. 559. Mr Bruce, who, in his journey through the deſert, ſuffered from the ſimoom, gives of it the following graphical deſcription: "At eleven o'clock, while we contemplated with great pleaſure the rugged top of Chiggre, to which we were faſt approaching, and where we were to ſolace ourſelves with plenty of good water, Idris our guide cried out, with a loud voice, Fall upon your faces, for here is the ſimoom. I ſaw from the ſouth-eaſt a haze come, in colour like the purple part of the rainbow, but not ſo compreſſed or thick. It did not occupy twenty yards in breadth, and was about twelve feet high from the ground. It was a kind of bluſh upon the air, and it moved very rapidly; for I ſcarce could turn to fall upon the ground with my head to the northward, when I felt the heat of its current plainly upon my face. We all lay flat on the ground as if dead, till Idris told us it was blown over. The meteor or purple haze which I ſaw was indeed paſſed, but the light air that ſtill blew was of heat to threaten ſuffocation. For my part, I found diſtinctly in my breaſt that I had imbibed a part of it, nor was I free of an aſthmatic ſenſation till I had been ſome months in Italy, at the baths of Poretta, near two years afterwards." Though the ſeverity of this blaſt ſeems to have paſſed over them almoſt inſtantaneouſly, it continued to blow ſo as to exhauſt them till twenty minutes before five in the afternoon, laſting through all its ſtages very near ſix hours, and leaving them in a ſtate of the utmoſt deſpondency.

SIMPLE, ſomething not mixed or compounded; in which ſenſe it ſtands oppoſed to *compound*.

SIMPLE, in the *Materia Medica*, a general name for all herbs or plants, as having each its particular virtue, whereby it becomes a ſimple remedy.

SIMPLICITY IN WRITING. If we examine the writers whoſe compoſitions have ſtood the teſt of ages, and obtained that higheſt honour, "the concurrent approbation of diſtant times and nations," we ſhall find that the character of ſimplicity is the unvarying circumſtance which alone hath been able to gain this univerſal homage from mankind. Among the Greeks, whoſe writers in general are of the ſimple kind, the divineſt poet, the moſt commanding orator, the fineſt hiſtorian, and deepeſt philoſopher, are, above the reſt, conſpicuouſly eminent in this great quality. The Roman writers riſe towards perfection according to that meaſure of ſimplicity which they mingle in their works; indeed they are all inferior to the Greek models. But who will deny that Lucretius, Horace, Virgil, Livy, Terence, Tully, are at once the ſimpleſt and beſt of Roman writers? unleſs we add the noble annaliſt who appeared in after-times; who, notwithſtanding the political turn of his genius, which ſometimes interferes, is admirable in this great quality, and by it far ſuperior to his contemporaries. It is this one circumſtance that hath raiſed the venerable Dante, the father of modern poetry, above the ſucceeding poets of his country, who could never long maintain the local and temporary honours beſtowed upon them; but have fallen under that juſt neglect which time will ever decree to thoſe who deſert a juſt ſimplicity for the florid colourings of ſtyle, contraſted phraſes, affected conceits, the mere trappings of compoſition and Gothic minutiæ. It is this which has given to Boileau the moſt laſting wreath in France, and to Shakeſpeare and Milton in England; eſpecially to the former, whoſe writings contain ſpecimens of perhaps the pureſt and ſimpleſt Engliſh that is anywhere to be found, except in the Bible or Book of Common Prayer. As it appears from theſe inſtances, that ſimplicity is the only univerſal characteriſtic of juſt writing, ſo the ſuperior eminence of the ſacred Scriptures in in this quality hath been generally acknowledged. One of the greateſt critics in antiquity, himſelf conſpicuous in the ſublime and ſimple manner, hath borne this teſtimony to the writings of Moſes and St Paul; and by parity of reaſon we muſt conclude, that had he been converſant with the other ſacred writers, his taſte and candour would have allowed them the ſame encomium.

It hath been often obſerved, even by writers of no mean rank, that the "Scriptures ſuffer in their credit by the diſadvantage of a literal verſion, while other ancient writings enjoy the advantage of a free and embelliſhed tranſlation." But in reality theſe gentlemen's concern is ill placed and groundleſs: for the truth is, "that moſt other writings are impaired by a literal tranſlation; whereas giving only a due regard to the idiom of different languages, the ſacred writings, when literally tranſlated, are then in their full perfection."

Now this is an internal proof, that in all other writings there is a mixture of local, relative, exterior ornament, which is often loſt in the transfuſion from one language to another. But the internal beauties, which depend not on the particular conſtruction of tongues, no change of tongue can deſtroy. Hence the Bible preſerves its native beauty and ſtrength alike in every language, by the ſole energy of unadorned phraſe, natural images, weight of ſentiment, and great ſimplicity.

It is in this reſpect like a rich vein of gold, which, under the ſevereſt trials of heat, cold, and moiſture, retains its original weight and ſplendour, without either loſs or alloy; while baſer metals are corrupted by earth, air, water, fire, and aſſimilated to the various elements through which they paſs.

This circumſtance, then, may be juſtly regarded as ſufficient to vindicate the compoſition of the ſacred Scriptures, as it is at once their chief excellence and greateſt ſecurity. It is their excellence, as it renders them intelligible and uſeful to all; it is their ſecurity, as it prevents their being diſguiſed by the falſe and capricious ornaments of vain or weak tranſlators. We may ſafely appeal to experience and fact for the confirmation of theſe remarks on the ſuperior ſimplicity, utility, and excellence, of the ſtyle of the Holy Scripture. Is there any book in the world ſo perfectly adapted to all capacities? that contains ſuch ſublime and exalted precepts, conveyed in ſuch an artleſs and intelligible ſtrain, that can be read with ſuch pleaſure and advantage by the lettered ſage and the unlettered peaſant?

SIMPLOCE. See Oratory, N° 72.

SIMPSON, Thomas, profeſſor of mathematics at the royal academy at Woolwich, fellow of the Royal Society, and member of the Royal Academy at Stockholm, was born at Market Boſworth in Leiceſterſhire in 1710. His father, a ſtuff-weaver, taught him only to read Engliſh, and brought him up to his own buſineſs; but meeting with a ſcientific pedlar, who likewiſe practiſed fortune-telling, young Simpſon by his aſſiſtance and advice left off weaving, and profeſſed aſtrology. As he improved in knowledge, however, he grew diſguſted with his pretended art; and renouncing it, was driven to ſuch difficulties for the ſubſiſtence of his family, that he came up to London, where he worked as a weaver, and taught mathematics at his ſpare hours. As his ſcholars increaſed, his abilities became better known, and he publiſhed his Treatiſe on Fluxions, by ſubſcription, in 1737: in 1740, he publiſhed his Treatiſe on the Nature and Laws of Chance; and Eſſays in Speculative and Mixed Mathematics. After theſe appeared his Doctrine of Annuities and Reverſions; Mathematical Diſſertations; Treatiſe on Algebra; Elements of Geometry; Trigonometry, Plane and Spherical; Select Exerciſes; and his Doctrine and Application of Fluxions, which he profeſſes to be rather a new work, than a ſecond edition of his former publication on fluxions. In 1743, he obtained the mathematical profeſſorſhip at Woolwich academy; and ſoon after was choſen a member of the Royal Society, when the preſident and council, in conſideration of his moderate circumſtances, were pleaſed to excuſe his admiſſion-fees, and his giving bonds for the ſettled future payments. At the academy he exerted all his abilities in inſtructing the pupils who were the immediate objects of his duty, as well as others whom the ſuperior officers of the ordnance permitted to be boarded and lodged in his houſe. In his manner of teaching he had a peculiar and happy addreſs, a certain dignity and perſpicuity, tempered with ſuch a degree of mildneſs, as engaged the attention, eſteem, and friendſhip, of his ſcholars. He therefore acquired great applauſe from his ſuperiors in the diſcharge of his duty. His application and cloſe confinement, however, injured his health. Exerciſe and a proper regimen were preſcribed to him, but to little purpoſe: for his ſpirits ſunk gradually, till he became incapable of performing his duty, or even of reading the letters of his friends. The effects of this decay of nature were greatly increaſed by vexation of mind, owing to the haughty and inſulting behaviour of his ſuperior the firſt profeſſor of mathematics. This perſon, greatly his inferior in mathematical accompliſhments, did what he could to make his ſituation uneaſy, and even to depreciate him in the public opinion: but it was a vain endeavour, and only ſerved to depreſs himſelf. At length his phyſicians adviſed his native air for his recovery, and he ſet out in February 1761; but was ſo fatigued by his journey, that upon his arrival at Boſworth, he betook himſelf to his chamber, and grew continually worſe till the day of his death, which happened on the 14th of May, in the 51ſt year of his age.

SIMSON, Dr Robert, profeſſor of mathematics in the univerſity of Glaſgow, was born in the year 1687 of a reſpectable family, which had held a ſmall eſtate in the county of Lanark for ſome generations. He was, we think, the ſecond ſon of the family. A younger brother was profeſſor of medicine in the univerſity of St Andrew's, and is known by ſome works of reputation, particularly a Diſſertation on the Nervous Syſtem, occaſioned by the Diſſection of a Brain completely Oſſified.

Dr Simſon was educated in the univerſity of Glaſgow under the eye of ſome of his relations who were profeſſors. Eager after knowledge, he made great progreſs in all his ſtudies; and, as his mind did not, at the very firſt openings of ſcience, ſtrike into that path which afterwards ſo ſtrongly attracted him, and in which he proceeded ſo far almoſt without a companion, he acquired in every walk of ſcience a ſtock of information, which, though it had never been much augmented afterwards, would have done credit to a profeſſional man in in any of his ftudies. He became, at a very early period, an adept in the philofophy and theology of the fchools, was able to fupply the place of a fick relation in the clafs of oriental languages, was noted for hiftorical knowledge, and one of the moft knowing botanifts of his time.

It was during his theological ftudies, as preparatory for his entering into orders, that mathematics took hold of his fancy. He ufed to tell in his convivial moments how he amufed himfelf when preparing his exercifes for the divinity hall. When tired with vague fpeculation, in which he did not meet with certainty to reward his labours, he turned up a book of oriental philology, in which he found fomething which he could difcover to be true or to be falfe, without going out of the line of ftudy which was to be of ultimate ufe to him. Sometimes even this could not relieve his fatigue. He then had recourfe to mathematics, which never failed to fatisfy and refrefh him. For a long while he reftricted himfelf to a very moderate ufe of the cordial, fearing that he would foon exhauft the fmall ftock which fo limited and abftract a fcience could yield; till at laft he found, that the more he learned, a wider field opened to his view, and fcenes that were inexhauftible. Becoming acquainted with fubjects far beyond the elements of the fcience, and with numbers of names celebrated during that period of ardent refearch all over Europe, he found it to be a manly and important ftudy, by which he was as likely to acquire reputation as by any other. About this time, too, a profpect began to open of making mathematics his profeffion for life. He then gave himfelf up to it without referve.

His original incitement to this ftudy as a treat, as fomething to pleafe and refrefh his mind in the midft of feverer tafks, gave a particular turn to his mathematical ftudies, from which he never could afterwards deviate. Perfpicuity and elegance are more attainable, and more difcernible, in pure geometry, than in any other parts of the fcience of meafure. To this therefore he chiefly devoted himfelf. For the fame reafon he preferred the ancient method of ftudying pure geometry, and even felt a diflike to the Cartefian method of fubftituting fymbols for operations of the mind, and ftill more was he difgufted with the fubftitution of fymbols for the very objects of difcuffion, for lines, furfaces, folids, and their affections. He was rather difpofed in the folution of an algebraical problem, where quantity alone was confidered, to fubftitute figure and its affections for the algebraical fymbols, and to convert the algebraic formula into an analogous geometrical theorem. And he came at laft to confider algebraic analyfis as little better than a kind of mechanical knack, in which we proceed without ideas of any kind, and obtain a refult without meaning, and without being confcious of any procefs of reafoning, and therefore without any conviction of its truth. And there is no denying, that if genuine unfophifticated tafte alone is to be confulted, Dr Simfon was in the right: for though it muft alfo be acknowledged, that the reafoning in algebra is as ftrict as in the pureft geometry of Euclid or Apollonius, the *expert* analyft has little perception of it as he goes on, and his final equation is not felt by himfelf as the refult of ratiocination, any more than if he had obtained it by Pafcal's arithmetical mill. This does not in the leaft diminifh our admiration of the algebraic analyfis; for its almoft boundlefs grafp, its rapid and certain procedure, and the delicate metaphyfics and great addrefs which may be difplayed in conducting it. Such, however, was the ground of the ftrong bias of Dr Simfon's mind to the analyfis of the ancient geometers. It increafed as he went forwards; and his veneration (we may call it his *love* or *affection*) for the ancient geometry was carried to a degree of idolatry. His chief labours were exerted in efforts to reftore the works of the ancient geometers; and he has nowhere beftowed much pains in advancing the modern difcoveries in mathematics. The noble inventions, for example, of fluxions and of logarithms, by which our progrefs in mathematical knowledge, and in the ufeful application of this knowledge, is fo much promoted, attracted the notice of Dr Simfon; but he has contented himfelf with demonftrating their truth on the genuine principles of the ancient geometry. Yet was he very thoroughly acquainted with all the modern difcoveries; and there are to be feen among his papers difcuffions and inveftigations in the Cartefian method, which fhow him thoroughly acquainted with all the principles, and even expert in the *tours de main*, of the moft refined fymbolical analyfis (A).

About the age of 25 Dr Simfon was chofen profeffor of mathematics in the univerfity of Glafgow. He went to London immediately after his appointment, and there formed an acquaintance with the moft eminent men of that bright era of Britifh fcience. Among thefe he always mentioned Captain Halley (the celebrated Dr Edmund Halley) with particular refpect; faying, that he had the moft acute penetration, and the moft juft tafte in that fcience, of any man he had ever known. And, indeed, Dr Halley has ftrongly exemplified both of thefe in his divination of the work of *Apollonius de Sectione Spatii*, and the 8th book of his *Conics*, and in fome of the moft beautiful theorems in Sir Ifaac Newton's *Principia*. Dr Simfon alfo admired the wide and mafterly fteps which Newton was accuftomed to take in his inveftigations, and his manner of fubftituting geometrical figures for the quantities which are obferved in the phenomena of nature. It was from Dr Simfon that the writer of this article had the remark which has been oftener than once repeated in the courfe of this Work, "That the 39th propofition of the firft book of the *Principia* was the moft important propofition

(A) In 1752 the writer of this article being then his fcholar, requefted him to examine an account which he gave him of what he thought a new curve (a conchoid having a circle for its bafe). Dr Simfon returned it next day with a regular lift of its leading properties, and the inveftigation of fuch as he thought his fcholar would not fo eafily trace. In this hafty fcrawl the lines related to the circle were familiarly confidered as arithmetical fractions of the radius confidered as unity. This was before Euler publifhed his Arithmetic of the Sines and Tangents, now in univerfal ufe.

poſition that had ever been exhibited to the phyſico-mathematical philoſopher;" and he uſed always to illuſtrate to his more advanced ſcholars the ſuperiority of the geometrical over the algebraic analyſis, by comparing the ſolution given by Newton of the inverſe problem of centripetal forces, in the 42d propoſition of that book, with the one given by John Bernoulli in the Memoirs of the Academy of Sciences at Paris for 1713. We have heard him ſay, that to his own knowledge Newton frequently inveſtigated his propoſitions in the ſymbolical way, and that it was owing chiefly to Dr Halley that they did not finally appear in that dreſs. But if Dr Simſon was well informed, we think it a great argument in favour of the ſymbolic analyſis, when this moſt ſucceſsful *practical artiſt* (for ſo we muſt call Newton when engaged in a taſk of diſcovery) found it conducive either to diſpatch or perhaps to his very progreſs.

Returning to his academical chair, Dr Simſon diſcharged the duties of a profeſſor for more than 50 years with great honour to the univerſity and to himſelf.

It is almoſt needleſs to ſay, that in his prelections he followed ſtrictly the Euclidian method in elementary geometry. He made uſe of Theodoſius as an introduction to ſpherical trigonometry. In the higher geometry he prelected from his own Conics; and he gave a ſmall ſpecimen of the *linear problems* of the ancients, by explaining the properties, ſometimes of the conchoid, ſometimes of the ciſſoid, with their application to the ſolution of ſuch problems. In the more advanced claſs he was accuſtomed to give Napier's mode of conceiving logarithms, i. e. quantities as generated by motion; and Mr Cotes's view of them, as the ſums of ratiunculæ; and to demonſtrate Newton's lemmas concerning the limits of ratios; and then to give the elements of the fluxionary calculus; and to finiſh his courſe with a ſelect ſet of propoſitions in optics, gnomonics, and central forces. His method of teaching was ſimple and perſpicuous, his elocution clear, and his manner eaſy and impreſſive. He had the reſpect, and ſtill more the affection, of his ſcholars.

With reſpect to his ſtudies, we have already informed the reader that they got an early bias to pure geometry, and to the elegant but ſcrupulous methods of the ancients.

We have heard Dr Simſon ſay, that it was in a great meaſure owing to Dr Halley that he ſo early directed his efforts to the reſtoration of the ancient geometers. He had recommended this to him, as the moſt certain way for him, then a very young man, both to acquire reputation, and to improve his own knowledge and taſte, and he preſented him with a copy of Pappus's Mathematical Collections, enriched with ſome of his own notes. The perſpicuity of the ancient geometrical analyſis, and a certain elegance in the nature of the ſolutions which it affords, eſpecially by means of the local theorems, ſoon took firm hold of his fancy, and made him, with the ſanguine expectation of a young man, direct his very firſt efforts to the recovery of this *in toto*; and the reſtoration of Euclid's Poriſms was the firſt taſk which he ſet himſelf. The accompliſhed geometer knows what a deſperate taſk this was, from the ſcanty and mutilated account which we have of this work in a ſingle paſſage of Pappus. It was an ambition which nothing but ſucceſs could juſtify in ſo young an adventurer. He ſucceeded; and ſo early as 1718 ſeemed to have been in complete poſſeſſion of this method of inveſtigation, which was conſidered by the eminent geometers of antiquity as their ſureſt guide through the labyrinths of the higher geometry. Dr Simſon gave a ſpecimen of his diſcovery in 1723 in the Philoſophical Tranſactions. And after this time he ceaſed not from his endeavours to recover that choice collection of Poriſms which Euclid had collected, as of the moſt general uſe in the ſolution of difficult queſtions. What ſome of theſe muſt have been was pointed out to Dr Simſon by the very nature of the general propoſition of Pappus, which he has reſtored. Others were pointed out by the lemmas which Pappus has given as helps to the young mathematician towards their demonſtration. And, being thus in poſſeſſion of a conſiderable number, their mutual relations pointed out a ſort of ſyſtem, of which theſe made a part, and of which the blanks now remained to be filled up.

Dr Simſon, having thus gained his favourite point, had leiſure to turn his attention to the other works of the ancient geometers; and the poriſms of Euclid now had only an occaſional ſhare. The *loci plani* of Apollonius was another taſk which he very early engaged in, and completed about the year 1738. But, after it was printed, he imagined that he had not given the *ipſiſſimæ propoſitiones* of Apollonius, and in the preciſe ſpirit and order of that author. The impreſſion lay by him for ſome years; and it was with great reluctance that he yielded to the intreaties of his mathematical friends, and publiſhed the work, in 1746, with ſome emendations, where he thought he had deviated fartheſt from his author. He quickly repented of this ſcanty conceſſion, and recalled what he could of the ſmall number of copies which he had given to the bookſellers, and the impreſſion again lay by him for years. He afterwards recorrected the work, and ſtill with ſome reluctance allowed it to come abroad as the Reſtitution of Apollonius. The public, however, had not been ſo faſtidious as Dr Simſon, and the work had acquired great celebrity, and he was now conſidered as one of the firſt and the moſt elegant geometers of the age: for, in the mean time, he had publiſhed his Conic Sections, a work of uncommon merit, whether we conſider it as equivalent to a complete reſtitution of the celebrated work of Apollonius Pergæus, or as an excellent ſyſtem of this important part of mathematics. It is marked with the ſame features as the *loci plani*, the moſt anxious ſolicitude to exhibit the very text of Apollonius, even in the propoſitions belonging to the books which had been completely loſt. Theſe could be recovered in no other way but by a thorough knowledge of the preciſe plan propoſed by the author, and by taking it for granted that the author had accurately accompliſhed this plan. In this manner did Viviani proceed in the firſt attempt which was made to reſtore the conics of Apollonius; and he has given us a detail of the proceſs of his conjectures, by which we may form an opinion of its juſtneſs, and of the probability how far he has attained the deſired object. Dr Simſon's view in his performance was ſomething different, deviating a little in this one caſe from his general track. He was not altogether pleaſed with the work of Viviani, even as augmented by the eighth book added by Halley, and his wiſh was to reſtore the ancient original. But, in the mean time, an

Simson. academical text book for conic sections was much wanted. He was much dissatisfied with those in common use; and he was not insensible of the advantage resulting from the consideration of these sections, independent of the cone first introduced by Dr Wallis. He therefore composed this excellent treatise as an elementary book, not to supersede, but to prepare for the study of Apollonius; and accordingly accommodates it to this purpose, and gives several important propositions in their proper places, *expressly as restitutions of Apollonius*, whom he keeps constantly in view through the whole work.

Much about this time Dr Simson seriously began to prepare a perfect edition of Euclid's Elements. The intimate acquaintance which he had by this time acquired with all the original works of the ancient geometers, and their ancient commentators and critics, encouraged him to hope that he could restore to his original lustre this leader in mathematical science; and the errors which had crept into this celebrated work, and which still remained in it, appeared of magnitude sufficient to merit the most careful efforts for their removal. The DATA also, which were in like manner the introduction to the whole art of geometrical investigation, seemed to call more loudly for his amending hand. For it appears that the Saracens, who have preserved to us the writings of the ancients, have contented themselves with admiring these celebrated works, and have availed themselves of the knowledge which they contain; but they have shown no inclination to add to the stock, or to promote the sciences which they had received. They could not do any thing without the synthetical books of the geometers; but, not meaning to go beyond the discoveries which they had made, they neglected all the books which related to the analytic art alone, and the greatest part of them (about 25 out of 30) have irrecoverably perished. The data of Euclid have fortunately been preserved, but the book was neglected, and the only ancient copies, which are but three or four, are miserably erroneous and mutilated. Fortunately, it is no very arduous matter to reinstate this work in its original perfection. The plan is precise, both in its extent and its method. It had been restored, therefore, with success by more than one author. But Dr Simson's comprehensive view of the whole analytical system pointed out to him many occasions for amendment. He therefore made its institution a joint task with that of the elements. All the lovers of true geometry will acknowledge their obligations to him for the edition of the Elements and data which he published about 1758. The text is corrected with the most judicious and scrupulous care, and the notes are inestimable, both for their information, and for the tendency which they must have to form the mind of the student to a true judgement and taste in mathematical subjects. The more accomplished reader will perhaps be sometimes disposed to smile at the axiom which seems to pervade the notes, "that a work of Euclid must be supposed without error or defect." If this was not the case, Euclid has been obliged to his editor in more instances than one. Nor should his greatest admirers think it impossible that in the progress of human improvement, a geometrical truth should occur to one of these latter days, which escaped the notice of even the Lincean Euclid. Such merit, however, Dr Simson nowhere claims, but lays every blame of error, omission, or obscurity, to the charge of Proclus, Theon, and other editors and commentators of the renowned Grecian. Simson.

There is another work of Apollonius on which Dr Simson has bestowed great pains, and has restored, as we imagine, *omnibus numeris perfectum*, viz. the SECTIO DETERMINATA; one of those performances which are of indispensable use in the application of the ancient analysis. This also seems to have been an early task, though we do not know the date of his labours on it. It did not appear till after his death, being then published along with the great work, the Porisms of Euclid, at the expence of the late Earl Stanhope, a nobleman intimately conversant with the ancient geometry, and zealous for its reception among the mathematicians of the present age. He had kept up a constant correspondence with Dr Simson on mathematical subjects; and at his death in 1768, engaged Mr Clow professor of logic in the university of Glasgow, to whose care the Doctor had left all his valuable papers, to make a selection of such as would serve to support and increase his well-earned reputation as THE RESTORER of ANCIENT GEOMETRY.

We have been thus particular in our account of Dr Simson's labours in these works, because his manner of execution, while it does honour to his inventive powers, and shows his just taste in mathematical composition, also confirms our former assertion, that he carried his respect for the ancient geometers to a degree of superstitious idolatry, and that his fancy, unchecked, viewed them as incapable of error or imperfection. This is distinctly to be seen in the emendations which he has given of the texts, particularly in his editions of Euclid. Not only every imperfection of the reading is ascribed to the ignorance of copyists, and every indistinctness in the conception, inconclusiveness in the reasoning, and defect in the method, is ascribed to the ignorance or mistake of the commentators; but it is all along assumed that the work was perfect in its kind; and that by exhibiting a perfect work, we restore the genuine original. This is surely gratuitous; and it is very possible that it has, in some instances, made Dr Simson fail of his anxious purpose, and give us even a better than the original. It has undoubtedly made him fail in what *should have been* his great purpose, viz. to give the world a connected system of the ancient geometrical analysis; such as would, in the first place, exhibit it in its most engaging form, elegant, perspicuous, and comprehensive; and, in the next place, such as should engage the mathematicians of the present age to adopt it as the most certain and successful conductor in those laborious and difficult researches in which the demands of modern science continually engage them. And this might have been expected, in the province of speculative geometry at least, from a person of such extensive knowledge of the properties of figure, and who had so eminently succeeded in the many trials which he had made of its powers. We might have expected that he would at least have exhibited in one systematic point of view, what the ancients had done in several detached branches of the science, and how far they had proceeded in the solution of the several successive classes of problems; and we might have hoped, that he would have instructed us in what manner we should apply that method to the solution of problems of a more elevated kind, daily presented

Simfon.

fented to us in the queftions of phyfico-mathematical fcience. By this he would have acquired diftinguifhed honour, and fcience would have received the moft valuable improvement. But Dr Simfon has done little of all this; and we cannot fay that great helps have been derived from his labours by the eminent mathematicians of this age, who are fuccefsfully occupied in advancing our knowledge of nature, or in improving the arts of life. He has indeed contributed greatly to the entertainment of the fpeculative mathematician, who is more delighted with the confcious exercife of his own reafoning powers, than with the final refult of his refearches. Yet we are not even certain that Dr Simfon has done this to the extent he wifhed and hoped. He has not engaged the liking of mathematicians to this analyfis, by prefenting it in the moft agreeable form. His own extreme anxiety to tread in the very footfteps of the original authors, has, in a thoufand inftances, precluded him from ufing his own extenfive knowledge, that he might not employ principles which were not of a clafs inferior to that of the queftion in hand. Thus, of neceffity, did the method appear trammelled. We are deterred from employing a procefs which appears to reftrain us in the application of the knowledge which we have already acquired; and, difgufted with the tedious, and perhaps indirect path, by which we muft arrive at an object which we fee clearly over the hedge, and which we could reach by a few fteps, of the fecurity of which we are otherwife perfectly affured. Thefe prepoffeffions are indeed founded on miftake; but the miftake is fuch, that all fall into it, till experience has enlarged their views. This circumftance alone has hitherto prevented mathematicians from acquiring that knowledge of the ancient analyfis which would enable them to proceed in their refearches with certainty, difpatch, and delight. It is therefore deeply to be regretted, that this eminent genius has occupied, in this fuperftitious palæology, a long and bufy life, which might have been employed in original works of infinite advantage to the world, and honour to himfelf.

Our readers will, it is hoped, confider thefe obfervations as of general fcientific importance, and as intimately connected with the hiftory of mathematics; and therefore as not improperly introduced in the biographical account of one of the moft eminent writers on this fcience. Dr Simfon claimed our notice as a mathematician; and his affectionate admiration of the ancient analyfis is the prominent feature of his literary character. By this he is known all over Europe; and his name is never mentioned by any foreign author without fome very honourable allufion to his diftinguifhed geometrical elegance and fkill. Dr James Moor, profeffor of Greek in the univerfity of Glafgow, no lefs eminent for his knowledge in ancient geometry than for his profeffional talents, put the following appofite infcription below a portrait of Dr Simfon:

GEOMETRIAM, SUB TYRANNO BARBARO SÆVA
SERVITUTE DIU SQUALENTEM, IN LIBERTATEM
ET DECUS ANTIQUUM VINDICAVIT
UNUS.

Yet it muft not be underftood that Dr Simfon's predilection for the geometrical analyfis of the ancients did fo far miflead him as to make him neglect the fymbolical analyfis of the prefent times; on the contrary, he was completely mafter of it, as has been already obferved, and frequently employed it. In his academical lectures to the ftudents of his upper claffes, he ufed to point out its proper province (which he by no means limited by a fcanty boundary), and in what cafes it might be applied with fafety and advantage even to queftions of pure geometry. He once honoured the writer of this article with the fight of a very fhort differtation on this fubject (perhaps the one referred to in the preface to his Conic Sections). In this piece he was perhaps more liberal than the moft zealous partifans of the fymbolical analyfis could defire, admitting as a fufficient equation of the Conic Sections $L = \frac{p^2 c}{x^2}$, where L is the *latus rectum*, x is the diftance of any point of the curve from the focus, p is the perpendicular drawn from the focus to the tangent in the given point, and c is the chord of the equicurve circle drawn through the focus. Unfortunately this differtation was not found among his papers. He fpoke in high terms of the Analytical Works of Mr Cotes, and of the two Bernoullis. He was confulted by Mr M'Laurin during the progrefs of his ineftimable Treatife of Fluxions, and contributed not a little to the reputation of that work. The fpirit of that moft ingenious algebraic demonftration of the fluxions of a rectangle, and the very procefs of the argument, is the fame with Dr Simfon's in his differtation on the limits of quantities. It was therefore from a thorough acquaintance with the fubject, and by a juft tafte, that he was induced to prefer his favourite analyfis, or, to fpeak more properly, to exhort mathematicians to employ it in its own fphere, and not to become ignorant of geometry, while he fuccefsfully employed the fymbolical analyfis in cafes which did not require it, and which fuffered by its admiffion. It muft be acknowledged, however, that in his later years, the difguft which he felt at the artificial and flovenly employment on fubjects of pure geometry, fometimes hindered him from even looking at the moft refined and ingenious improvements of the algebraic analyfis which occur in the writings of Euler, D'Alembert, and other eminent mafters. But, when properly informed of them, he never failed to give them their due praife; and we remember him fpeaking, in terms of great fatisfaction, of an improvement of the infinitefimal calculus, by D'Alembert and De la Grange, in their refearches concerning the propagation of found, and the vibrations of mufical cords.

And that Dr Simfon not only was mafter of this calculus and the fymbolical calculus in general, but held them in proper efteem, appears from two valuable differtations to be found in his pofthumous works; the one on logarithms, and the other on the limits of ratios. The laft, in particular, fhows how completely he was fatisfied with refpect to the folid foundation of the method of fluxions; and it contains an elegant and ftrict demonftration of all the applications which have been made of the method by its illuftrious author to the objects of pure geometry.

We hoped to have given a much more complete and inftructive account of this eminent geometer and his works, by the aid of a perfon fully acquainted with both, and able to appreciate their value; but an accident has deprived us of this affiftance, when it was too late to procure an equivalent: and we muft requeft our readers to accept of this very imperfect account, fince we cannot do juftice to Dr Simfon's merit, unlefs almoft

equally

equally converfant in all the geometry of the ancient Greeks.

The life of a literary man rarely teems with anecdote; and a mathematician, devoted to his ftudies, is perhaps more abftracted than any other perfon from the ordinary occurrences of life, and even the ordinary topics of converfation. Dr Simfon was of this clafs; and, having never married, lived entirely a college life. Having no occafion for the commodious houfe to which his place in the univerfity entitled him, he contented himfelf with chambers, good indeed, and fpacious enough for his fober accommodation, and for receiving his choice collection of mathematical writers, but without any decoration or commodious furniture. His official fervant fufficed for valet, footman, and chambermaid. As this retirement was entirely devoted to ftudy, he entertained no company in his chambers, but in a neighbouring houfe, where his apartment was facred to him and his guefts.

Having in early life devoted himfelf to the reftoration of the works of the ancient geometers, he ftudied them with unremitting attention; and, retiring from the promifcuous intercourfe of the world, he contented himfelf with a fmall fociety of intimate friends, with whom he could lay afide every reftraint of ceremony or referve, and indulge in all the innocent frivolities of life. Every Friday evening was fpent in a party at whift, in which he excelled, and took delight in inftructing others, till increafing years made him lefs patient with the dulnefs of a fcholar. The card-party was followed by an hour or two dedicated folely to playful converfation. In like manner, every Saturday he had a lefs felect party to dinner at a houfe about a mile from town. The Doctor's long life gave him occafion to fee the *dramatis perfonæ* of this little theatre feveral times completely changed, while he continued to give it a perfonal identity: fo that, without any defign or wifh of his own, it became, as it were, his own houfe and his own family, and went by his name. In this ftate did the prefent writer firft fee it, with Dr Simfon as its father and head, refpected and beloved by every branch; for, as it was for relaxation, and not for the enjoyment of his acknowledged fuperiority, that he continued this habit of his early youth; and as his notions "of a fine talk" did not confift in the pleafure of having "toffed and gored a good many to-day," his companions were as much at their eafe as he wifhed to be himfelf; and it was no fmall part of their entertainment (and of his too), to fmile at thofe innocent deviations from common forms, and thofe miftakes with refpect to life and manners, which an almoft total retirement from the world, and inceffant occupation in an abftract fcience, caufed this venerable prefident frequently to exhibit. Thefe are remembered with a more affecting regret, that they are now "with the days that are paft," than the moft pithy apophthegms, ufhered in with an emphatical, "Why, Sir!" or "No, Sir!" which precludes all reply. Dr Simfon never exerted his prefidial authority, unlefs it were to check fome infringement of good breeding, or any thing that appeared unfriendly to religion or purity of manners; for thefe he had the higheft reverence. We have twice heard him fing (he had a fine voice and moft accurate ear) fome lines of a Latin hymn to the Divine Geometer, and each time the rapturous tear ftood in his eye.

But we afk the reader's pardon for this digreffion; it is not however ufelefs, fince it paints the man as much as any recital of his ftudies; and to his acquaintances we are certain that it will be an acceptable memorandum. To them it was often matter of regret, that a perfon of fuch eminent talents, which would have made him fhine equally in any line of life, fhould have allowed himfelf to be fo completely devoted to a ftudy which abftracted him from the ordinary purfuits of men, unfitted him for the active enjoyment of life, and kept him out of thofe walks which they frequented, and where they would have rejoiced to meet him.

Dr Simfon was of an advantageous ftature, with a fine countenance; and even in his old age had a graceful carriage and manner, and always, except when in mourning, dreffed in white cloth. He was of a cheerful difpofition; and though he did not make the firft advances to acquaintance, had the moft affable manner, and ftrangers were at perfect eafe in his company. He enjoyed a long courfe of uninterrupted health; but towards the clofe of life fuffered from an acute difeafe, and was obliged to employ an affiftant in his profeffional labours for a few years preceding his death, which happened in 1768, at the age of 81. He left to the univerfity his valuable library, which is now arranged apart from the reft of the books, and the public ufe of it is limited by particular rules. It is confidered as the moft choice collection of mathematical books and manufcripts in the kingdom, and many of them are rendered doubly valuable by Dr Simfon's notes.

SIN, a breach or tranfgreffion of fome divine law or command.

SINAI, or SINA, a famous mountain of Arabia Petræa, upon which God gave the law to Mofes. It ftands in a kind of peninfula, formed by the two arms of the Red fea, one of which ftretches out towards the north, and is called the *gulf of Kolfum;* the other extends towards the eaft, and is called the *gulf of Elan*, or the *Elanitifh fea*. At this day the Arabians call Mount Sinai by the name of *Tor*, that is, the "mountain," by way of excellence; or *Gibel* or *Jibel Moufa*, "the mountain of Mofes." It is 260 miles from Cairo, and generally it requires a journey of ten days to travel thither. The wildernefs of Sinai, where the Ifraelites continued encamped for almoft a year, and where Mofes erected the tabernacle of the covenant, is confiderably elevated above the reft of the country; and the afcent to it is by a very craggy way, the greateft part of which is cut out of the rock; then one comes to a large fpace of ground, which is a plain furrounded on all fides by rocks and eminences, whofe length is nearly 12 miles. Towards the extremity of this plain, on the north fide, two high mountains fhow themfelves, the higheft of which is called *Sinai* and the other *Horeb*. The tops of Horeb and Sinai have a very fteep afcent, and do not ftand upon much ground, in comparifon to their extraordinary height: that of Sinai is at leaft one-third part higher than the other, and its afcent is more upright and difficult.

Two German miles and a half up the mountain ftands the convent of St Catharine. The body of this monaftery is a building 120 feet in length and almoft as many in breadth. Before it ftands another fmall building, in which is the only gate of the convent, which remains always fhut, except when the bifhop is here.

Niebuhr's Travels, vol i. p. 192.

here. At other times, whatever is introduced within the convent, whether men or provisions, is drawn up by the roof in a basket, and with a cord and a pulley. The whole building is of hewn stone; which, in such a desert, must have cost prodigious expence and pains. Near this chapel issues a fountain of very good fresh water; it is looked upon as miraculous by some who cannot conceive how water can flow from the brow of so fresh and barren a mountain. Five or six paces from it they show a stone, the height of which is four or five feet, and breadth about three, which, they say, is the very stone whence Moses caused the water to gush out. Its colour is of a spotted gray, and it is as it were set in a kind of earth, where no other rock appears. The stone has 12 holes or channels, which are about a foot wide, whence it is thought the water came forth for the Israelites to drink.

Much has been said of the writings to be seen at Sinai and in the plain about it; and such were the hopes of discoveries respecting the wanderings of the Israelites from these writings, that Dr Clayton bishop of Clogher offered 500l. sterling to defray the expences of journey to any man of letters who would undertake to copy them. No man, we believe, undertook this task: and the accurate Danish traveller Niebuhr found no writings there, but the names of persons who had visited the place from curiosity, and of Egyptians who had chosen to be buried in that region.

SINAPIS, MUSTARD, a genus of plants belonging to the class *tetradynamia*, and to the order *siliquosa*; and in the natural system ranged under the 39th order, *Siliquosæ*. See BOTANY *Index*.

SINAPISM, in *Pharmacy*, an external medicine, in form of a cataplasm, composed chiefly of mustard-seed pulverized, and other ingredients mentioned in the preceding article.

SINCERITY, honesty of intention, freedom from hypocrisy. See MORAL PHILOSOPHY, N° 157.

SINCIPUT, in *Anatomy*, the forepart of the head, reaching from the forehead to the coronal suture.

SINDY, a province of Hindostan Proper, bounded on the west by Makran, a province of Persia; on the north by the territories of the king of Candahar; on the north-east by those of the Seiks; on the east by a sandy desert; and on the south-east by Cutch. It extends along the course of the river Sinde or Indus from its mouth to Behker or Bhakor, on the frontiers of Moultan. Reckoned that way, it is 300 miles long; and its breadth, in its widest part, is about 160. In many particulars of soil and climate, and in the general appearance of the surface, Sindy resembles Egypt; the lower part of it being composed of rich vegetable mould, and extended into a wide dell; while the upper part of it is a narrow slip of country, confined on one side by a ridge of mountains, and on the other by a sandy desert, the river Indus, equal at least to the Nile, winding through the midst of this level valley, and annually overflowing it. During great part of the south-west monsoon, or at least in the months of July, August, and part of September, which is the rainy season in most other parts of India, the atmosphere is here generally clouded; but no rain falls except very near the sea. Indeed, very few showers fall during the whole year; owing to which, and the neighbourhood of the sandy deserts, which bound it on the east and on the north-west, the heats are so violent, and the winds from those quarters so pernicious, that the houses are contrived so as to be occasionally ventilated by means of apertures on the tops of them, resembling the funnels of small chimneys. When the hot winds prevail, the windows are closely shut; and the lowest part of the current of air, which is always the hottest, being thus excluded, a cooler, because more elevated, part descends into the house through the funnels. By this contrivance also vast clouds of dust are excluded; the entrance of which would alone be sufficient to render the house uninhabitable. The roofs are composed of thick layers of earth instead of terraces. Few countries are more unwholesome to European constitutions, particularly the lower part of the Delta. The prince of this province is a Mahometan, tributary to the king of Candahar. He resides at Hydrabad, although Tatta is the capital. The Hindoos, who were the original inhabitants of Sindy, are by their Mahometan governors treated with great rigour, and denied the public exercise of their religion; and this severity drives vast numbers of them into other countries. The inland parts of Sindy produce saltpetre, sal-ammoniac, borax, bezoar, lapis lazuli, and raw silk. They have also manufactories of cotton and silk of various kinds; and they make fine cabinets, inlaid with ivory, and finely lackered. They also export great quantities of butter, clarified and wrapt up in duppas, made of the hides of cattle. The ladies wear hoops of ivory on both their arms and legs, which when they die are burnt with them. They have large black cattle, excellent mutton, and small hardy horses. Their wild game are deer, hares, antelopes, and foxes, which they hunt with dogs, leopards, and a small fierce creature called a shiahgush.

SINE, or *Right SINE of an Arch*, in *Trigonometry*, is a right line drawn from one end of that arch, perpendicular to the radius drawn to the other end of the arch; being always equal to half the cord of twice the arch. See TRIGONOMETRY and GEOMETRY.

SINECURE, a nominal office, which has a revenue without any employment.

SINEW, a tendon, that which unites the muscles to the bones.

SINGING, the action of making divers inflections of the voice, agreeable to the ear, and correspondent to the notes of a song or piece of melody. See MELODY.

The first thing to be done in learning to sing, is to raise a scale of notes by tones and semitones to an octave, and descend by the same notes; and then to rise and fall by greater intervals, as a third, fourth, fifth, &c. and to do all this by notes of different pitch. Then these notes are represented by lines and spaces, to which the syllables *fa*, *sol*, *la*, *mi*, are applied, and the pupil taught to name each line and space thereby; whence this practice is called *sol-faing*, the nature, reason, effects, &c. whereof, see under the article SOLFAING.

SINGING of Birds. It is worthy of observation, that the female of no species of birds ever sings: with birds it is the reverse of what occurs in human kind. Among the feathered tribe, all the cares of life fall to the lot of the tender sex; theirs is the fatigue of incubation; and the principal share in nursing the helpless brood: to alleviate these fatigues, and to support her under them, nature hath given to the male the song, with all the little

little blandiſhments and ſoothing arts; theſe he fondly exerts (even after courtſhip) on ſome ſpray contiguous to the neſt, during the time his mate is performing her parental duties. But that ſhe ſhould be ſilent is alſo another wiſe proviſion of nature, for her ſong would diſcover her neſt; as would a gaudineſs of plumage, which, for the ſame reaſon, ſeems to have been denied her.

On the ſong of birds ſeveral curious experiments and obſervations have been made by the Hon. Daines Barrington. See *Phil. Tranſ.* vol. lxiii.

SINGULAR NUMBER, in *Grammar*, that number of nouns and verbs which ſtands oppoſed to plural. See GRAMMAR, N° 14.

SINISTER, ſomething on or towards the left hand. Hence ſome derive the word *ſiniſter à ſinendo;* becauſe the gods, by ſuch auguries, permit us to proceed in our deſigns.

SINISTER, is ordinarily uſed among us for unlucky; though, in the ſacred rites of divination, the Romans uſed it in an oppoſite ſenſe. Thus *avis ſiniſtra*, or a bird on the left hand, was eſteemed a happy omen: whence, in the law of the 12 tables, *Ave ſiniſtra populi magiſter eſto*.

SINISTER, in *Heraldry*. The ſiniſter ſide of an eſcutcheon is the left-hand ſide; the ſiniſter chief, the left angle of the chief; the ſiniſter baſe, the left-hand part of the baſe.

SINISTER Aſpect, among aſtrologers, is an appearance of two planets happening according to the ſucceſſion of the ſigns; as Saturn in Aries, and Mars in the ſame degree of Gemini.

SINISTRI, a ſet of ancient heretics, thus called becauſe they held the left hand in abhorrence, and made it a point of religion not to receive any thing therewith.

SINKING FUND, a proviſion made by parliament, conſiſting of the ſurpluſage of other funds, intended to be appropriated to the payment of the national debt; on the credit of which very large ſums have been borrowed for public uſes.

As the funding ſyſtem had been adopted in other countries long before it was reſorted to in Great Britain, a proviſion of this kind had appeared neceſſary at a much earlier period, and had been eſtabliſhed in Holland in 1655, and in the eccleſiaſtical ſtates in 1685. Theſe funds were both formed by the reduction of the intereſt on the public debts, and by appropriating the annual ſum thus ſaved to the gradual diſcharge of the principal.

In the reign of King William, when the mode of providing for extraordinary expences was firſt adopted in this country, the particular tax on which money was borrowed, generally produced much more than was ſufficient to pay the annual intereſt, and the ſurplus was applied in ſinking the principal, which was generally effected in a few years. Had this plan been purſued, there never could have been any great accumulation of public debts; but, as the expenditure increaſed, and the neceſſity of loans of ſtill greater amount became more frequent, it was found difficult to provide for the annual intereſt of the ſums thus borrowed; and the repayment of the principal was either put off to a diſtant period, or left without any proviſion to the chance of more flouriſhing times.

Some of the effects of an accumulating public debt ſoon became evident in the diſcount at which all government ſecurities ſold, and in the difficulties experienced in providing for the annual expenditure; the propriety of reducing, and even of wholly diſcharging, the debt, was generally acknowledged; and the plan of a ſinking fund was recommended in a pamphlet publiſhed in 1701. In 1713 Mr Archibald Hutchiſon preſented to George I. a plan for payment of the public debts. In 1715 different projects for this purpoſe were publiſhed by Edward Leigh, Mr Aſgill, and others. And in 1717 a plan for the gradual diſcharge of the debt was actually adopted, which was afterwards generally known by the name of the ſinking fund.

For a few years the fund was ſtrictly applied to the purpoſes for which it was eſtabliſhed; and ſo well were its nature and importance then underſtood, that money was at the ſame time borrowed for extraordinary expences. In 1724, the ſum of 15,144l. 19s. was taken from the fund, to make good the loſs to the treaſury from the reduction of the value of gold coin; and within 12 years from its eſtabliſhment it was charged with the intereſt of new loans. In 1733, the groſs ſum of half a million was taken from it towards the ſupplies, at which time the medium annual produce of the fund for five years had been 1,212,000l. This amount would have fully diſcharged the debt which then exiſted, but the alienation of it was continued.

This was ſucceeded by the conſolidated fund, one object of which was, to lay the foundation of a new ſinking fund, and conſiſting, like the old one, in the application of the principle of compound intereſt. On this occaſion Mr Pitt conſulted the late Dr Price, who communicated three plans, one of which was afterwards adopted, but with ſuch alterations as greatly affected its efficacy, and which it has been ſince found neceſſary to correct. By the act paſſed for carrying this ſcheme into execution, the annual ſum of 1,000,000l. was placed in the hands of commiſſioners, to be iſſued in four equal quarterly payments, and to be applied either in paying off ſuch redeemable annuities as were at or above par, or in the purchaſe of annuities below par, at the market-price.

On the 17th of February, 1792, Mr Pitt propoſed that the ſum of 400,000l. ſhould be iſſued in addition to the million, for the purpoſe of accelerating the operation of the fund: and ſtated that it might be expected that 25 millions of 3 per cents would be paid off by the year 1800; and that in the year 1808, the fund would amount to 4,000,000l. per annum, the ſum to which it was then reſtricted. The injudicious reſtriction of the fund to 4,000,000l. per annum, was done away by an act paſſed in 1802, which directed that the produce of the two funds ſhould continue to accumulate, without any limitation as to its amount, and be from time to time applied, according to the former proviſions, in the redemption or purchaſe of ſtock, until the whole of the perpetual redeemable annuities, exiſting at the time of paſſing the act, ſhall have been completely paid off. At the ſame time, the annual grant of 200,000l. in aid of the fund, was made a permanent charge, to be iſſued in quarterly payments from the conſolidated fund, in the ſame manner as the original million per annum. In conſequence of theſe improvements, the increaſe of the fund has been much greater than it was originally

originally estimated; and on the 1st of February, 1806, was as follows:

Annual charge by act of 26 Geo. III. - -	L. 1,000,000 0 0
Ditto 42 Geo. III. -	200,000 0 0
Annuities for 99 and 96 years, expired 1792 -	54,880 14 6
Short annuities, expired 1787	25,000 0 0
Life annuities, unclaimed and expired - -	50,308 5 7
Dividend on 98,386,402l. at 3 per cent. - -	2,951,592 1 2
Ditto on 2,617,400l. at 4 per cent.	104,696 0 0
Ditto on 142,000l. at 5 per cent.	7,100 0 0
One per cent. on capitals erected since 1723 -	3,202,672 1 10
Total,	L. 7,596,249 3 1

This sum is exclusive of the fund for the reduction of the public debt of Ireland, which at the above period amounted to 479,537l. 8s. and of the fund for reduction of the imperial debt, which amounted to 56,960l. 9s. 4d.

The progress of the fund from the commencement of its operation on 1st August 1786, to the 1st February 1806, will appear from the following statement of the total amount of the stock redeemed by the commissioners up to the latter period.

Consolidated 3 per cent. annuities	L. 39,922,421
Reduced 3 per cent. annuities	51,493,981
Old South sea annuities	3,492,000
New South sea annuities	2,783,000
Three per cents 1751 -	695,000
Consolidated 4 per cent. annuities	2,617,400
Navy 5 per cent. annuities	142,000
Total,	L. 101,145,802

The total sum which had been paid for this amount of stock was, 62,842,782l. 7s. 10d. the consolidated 3 per cents having been bought up on an average at 61l. per cent. and the reduced at somewhat less.

The progress already made by the fund, and the important effect it has had in supporting the value of the government securities at a time when it has been necessary to borrow unprecedented sums in almost every year, sufficiently demonstrate the great utility of this measure. As its increase will be continually augmenting, it will, if steadily persevered in, and faithfully applied, become ultimately capable of discharging a debt of any amount with which it is possible to suppose the country will ever be encumbered.

SINOPLE, in *Heraldry*, denotes vert, or green colour in armories.—Sinople is used to signify love, youth, beauty, rejoicing, and liberty; whence it is that letters of grace, ambition, legitimation, &c. are always sealed with green wax.

SINUOSITY, a series of bends and turns in arches or other irregular figures, sometimes jutting out and sometimes falling in.

SINUS, in *Anatomy*, denotes a cavity in certain bones and other parts, the entrance whereof is very narrow, and the bottom wider and more spacious.

Sinus, in *Surgery*, a little cavity or sacculus, frequently formed by a wound or ulcer, wherein pus is collected.

SIPHON. See Hydrodynamics.

SIPHONANTHUS, a genus of plants belonging to the class of tetrandria and order of monogynia. See Botany *Index*.

SIPONTUM, Sepuntum, or *Sipus*, in *Ancient Geography*, a town of Apulia, so denominated (according to Strabo) from the great quantity of *sepiæ* or cuttlefish that are thrown upon the coast. Diomede is supposed by the same author to have been the founder of this place; which appears from Livy to have become a colony of Roman citizens. In the early ages of Christian hierarchy, a bishop was fixed in this church; but, under the Lombards, his see was united to that of Beneventum. Being again separated, Sipontum became an archiepiscopal diocese in 1094, about which time it was so ill treated by the Barbarians, that it never recovered its splendour, but sunk into such misery, that in 1260 it was a mere desert, from the want of inhabitants, the decay of commerce, and the insalubrity of the air. Manfred having taken these circumstances into consideration, began in 1261 to build a new city on the sea-shore, to which he removed the few remaining Sipontines. (See the article Manfredonia). Sipontum was situated at the distance of a mile from the shore. Excepting a part of its Gothic cathedral, scarce one stone of the ancient city now remains upon another.

SIPUNCULUS, in *Natural History*, a genus of the class of vermes, and order intestina. See Helminthology *Index*.

SIR, the title of a knight or baronet, which, for distinction's sake, as it is now given indiscriminately to all men, is always prefixed to the knight's Christian name, either in speaking or writing to them.

SIRCAR, any office under the government in Hindostan. It is sometimes used for the state of government itself. Likewise a province, or any number of pergunnahs placed under one head in the government books, for conveniency in keeping accounts. In common usage in Bengal, the under banyans of European gentleman are called *sircars*.

SIRE, a title of honour formerly given to the king of France as a mark of sovereignty.

Sire, was likewise anciently used in the same sense with *sieur* and *seigneur*, and applied to barons, gentlemen, and citizens.

SIRENS, in fabulous history, certain celebrated songstresses who were ranked among the demigods of antiquity. Hyginus places their birth among the consequences of the rape of Proserpine. Others make them daughters of the river Acheloüs and one of the muses*. The number of the Sirens was three, and their names were *Parthenope*, *Lygea*, and *Leucosia*. Some make them half women and half fish; others, half women and half birds. There are antique representations of them still subsisting under both these forms. Pausanias tells us, that the Sirens, by the persuasion of Juno, challenged the Muses to a trial of skill in singing; and these having vanquished them, plucked the golden feathers from the wings of the Sirens, and formed them into crowns,

* Ovid Met. lib. iv.

crowns, with which they adorned their own heads. The Argonauts are ſaid to have been diverted from the enchantment of their ſongs by the ſuperior ſtrains of Orpheus: Ulyſſes, however, had great difficulty in ſecuring himſelf from ſeduction. See *Odyſ.* lib. xii.

Pope, in his notes to the twelfth book of the Odyſſey, obſerves, the critics have greatly laboured to explain what was the foundation of this fiction of the Sirens. We are told by ſome, that the Sirens were queens of certain ſmall iſlands named *Sirenuſæ*, that lie near Capræa in Italy, and chiefly inhabited the promontory of Minerva, upon the top of which that goddeſs had a temple, as ſome affirm, built by Ulyſſes. Here there was a renowned academy, in the reign of the Sirens, famous for eloquence and the liberal ſciences, which gave occaſion to the invention of this fable of the ſweetneſs of the voice and attracting ſongs of the Sirens. But why then are they fabled to be deſtroyers, and painted in ſuch dreadful colours? We are told, that at laſt the ſtudents abuſed their knowledge, to the colouring of wrong, the corruption of manners, and the ſubverſion of government: that is, in the language of poetry, they were feigned to be transformed into monſters, and with their muſic to have enticed paſſengers to their ruin, who there conſumed their patrimonies, and poiſoned their virtues with riot and effeminacy. The place is now called *Maſſa*. Some writers tell us of a certain bay, contracted within winding ſtraits and broken cliffs, which, by the ſinging of the winds and beating of the waters, returns a delightful harmony, that allures the paſſenger to approach, who is immediately thrown againſt the rocks, and ſwallowed up the violent eddies. Thus Horace, moraliſing, calls idleneſs a *Siren*.

> ——*Vitanda eſt improba Siren*
> *Deſidia.*——

But the fable may be applied to all pleaſures in general, which, if too eagerly purſued, betray the incautious into ruin; while wiſe men, like Ulyſſes, making uſe of their reaſon, ſtop their ears againſt their inſinuations.

The learned Mr Bryant ſays, that the Sirens were Cuthite and Canaanitiſh prieſts, who had founded temples in Sicily, which were rendered infamous on account of the women who officiated. They were much addicted to cruel rites, ſo that the ſhores upon which they reſided are deſcribed as covered with the bones of men deſtroyed by their artifice. *Virgil. Æneid.* lib. v. ver. 864.

All ancient authors agree in telling us, that Sirens inhabited the coaſt of Sicily. The name, according to Bochart, who derives it from the Phœnician language, implies a ſongſtreſs. Hence it is probable, ſays Dr Burney, that in ancient times there may have been excellent ſingers, but of corrupt morals, on the coaſt of Sicily, who, by ſeducing voyagers, gave riſe to this fable. And if this conjecture be well founded, he obſerves, the Muſes are not the only pagan divinities who preſerved their influence over mankind in modern times; for every age has its Sirens, and every Siren her votaries; when beauty and talents, doth powerful in themſelves, are united, they become ſtill more attractive.

SIREN, in *Zoology*, a genus of animals belonging to the claſs of *amphibia* and the order of *meantes*. It is a biped, naked, and furniſhed with a tail; the feet are brachiated with claws. This animal was diſcovered by Dr Garden in Carolina; it is found in ſwampy and muddy places, by the ſides of pools, under the trunks of old trees that hang over the water. The natives call it by the name of *mud-inguana*. Linnæus firſt apprehended, that it was the larva of a kind of lizard; but as its fingers are furniſhed with claws, and it makes a croaking noiſe, he concluded from theſe properties, as well as from the ſituation of the anus, that it could not be the larva of the lizard, and therefore formed of it a new genus under the name of *ſiren*. He was alſo obliged to eſtabliſh for this uncommon animal a new order called *meantes* or *gliders*; the animals of which are amphibious, breathing by means of gills and lungs, and furniſhed with arms and claws.

Phil. Tranſ. vol. lvi. p. 189.

SIREX, a genus of inſects belonging to the order of *hymenopteræ*. See ENTOMOLOGY *Index*.

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

SIRIUS, in *Aſtronomy*, a bright ſtar in the conſtellation Canis. See ASTRONOMY, N° 403, &c.

SIRLET, FLAVIUS, an eminent Roman engraver on precious ſtones: his Laocoon, and repreſentations in miniature of antique ſtatues at Rome, are very valuable and ſcarce. He died in 1737.

SIROCCO, a periodical wind which generally blows in Italy and Dalmatia every year about Eaſter. It blows from the ſouth-eaſt by ſouth: it is attended with heat, but not rain; its ordinary period is twenty days, and it uſually ceaſes at ſunſet. When the ſirocco does not blow in this manner, the ſummer is almoſt free from weſterly winds, whirlwinds, and ſtorms. This wind is prejudicial to plants, drying and burning up the buds; though it hurts not men any otherwiſe than by cauſing an extraordinary weakneſs and laſſitude; inconveniences that are fully compenſated by a plentiful fiſhing, and a good crop of corn on the mountains. In the ſummer time, when the weſterly wind ceaſes for a day, it is a ſign that the ſirocco will blow the day following, which uſually begins with a ſort of whirlwind.

Fortis's Travels into Dalmatia, p. 277.

SISKIN. See FRINGILLA, ORNITHOLOGY *Index*.

SISON, BASTARD STONE PARSLEY, a genus of plants belonging to the claſs of pentandria, and to the order of digynia; and in the natural ſyſtem arranged under the 45th order, *umbellatæ*. See BOTANY *Index*.

SISTRUM, or CISTRUM, a kind of ancient muſical inſtrument uſed by the prieſts of Iſis and Oſiris. It is deſcribed by Spon as of an oval form, in manner of a racket, with three ſticks traverſing it breadthwiſe; which playing freely by the agitation of the whole inſtrument, yielded a kind of ſound which to them ſeemed melodious. Mr Malcom takes the ſiſtrum to be no better than a kind of rattle. Oiſelius obſerves, that the ſiſtrum is found repreſented on ſeveral medals, and on taliſmans.

SISYMBRIUM, WATER-CRESES, a genus of plants belonging to the claſs of *tetradynamia*, and to the order of *ſiliquoſa*; and in the natural ſyſtem ranged under the 39th order, *Siliquoſæ*. See BOTANY *Index*.

SISYPHUS, in fabulous hiſtory, one of the deſcendents of Eolus, married Merope, one of the Pleiades, who bore him Glaucus. He reſided at Epyra in Peloponneſus, and was a very crafty man. Others ſay, that he was a Trojan ſecretary, who was puniſhed for diſco-

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vering secrets of state; and others again, that he was a notorious robber, killed by Theseus. However, all the poets agree that he was punished in Tartarus for his crimes, by rolling a great stone to the top of a hill, which constantly recoiled, and, rolling down incessantly, renewed his labour.

SISYRINCHIUM, a genus of plants belonging to the class of *gynandria*, and order of *triandria*; and in the natural system ranged under the 5th order, *Ensatæ*. See BOTANY *Index*.

SITE, denotes the situation of an house, &c. and sometimes the ground-plot or spot of earth on which it stands.

SITTA, NUTHATCH, a genus of birds belonging to the order of *picæ*. See ORNITHOLOGY *Index*.

SITOPHYLAX, Σιτοφυλαξ, formed from σιτος "corn," and φυλαξ, "keeper," in antiquity, an Athenian magistrate, who had the superintendence of the corn, and was to take care that nobody bought more than was necessary for the provision of his family. By the Attic laws, particular persons were prohibited from buying more than fifty measures of wheat a man; and that such persons might not purchase more, the sitophylax was appointed to see the laws properly executed. It was a capital crime to prevaricate in it. There were 15 of these *sitophylaces*, ten for the city, and five for the Piræus.

SITUS, in *Algebra* and *Geometry*, denotes the situation of lines, surfaces, &c. Worfius delivers some things in geometry, which are not deduced from common analysis, particularly matters depending on the *situs* of lines and figures. Leibnitz has even founded a particular kind of analysis upon it, called *calculus situs*.

SIVA, a name given by the Hindoos to the Supreme Being, when considered as the avenger or destroyer. Sir William Jones has shown that in several respects the character of Jupiter and Siva are the same. As Jupiter overthrew the Titans and giants, so did Siva overthrow the Daityas, or children of Diti, who frequently rebelled against Heaven; and as during the contest the god of Olympus was furnished with lightning and thunderbolts by an eagle, so Brahma, who is sometimes represented riding on the Garuda, or eagle, presented the god of destruction with fiery shafts. Siva also corresponds with the Stygian Jove, or Pluto; for, if we can rely on a Persian translation of the Bhágavat, the sovereign of Pátála, or the infernal regions, is the king of serpents, named *Seshanaga*, who is exhibited in painting and sculpture, with a diadem and sceptre, in the same manner as Pluto. There is yet another attribute of Siva, or Mahádéva, by which he is visibly distinguished in the drawings and temples of Bengal. To destroy, according to the Vedantis of India, the Sufis of Persia, and many philosophers of our European schools, is only to generate and reproduce in another form. Hence the god of destruction is holden in this country to preside over generation, as a symbol of which he rides on a white bull. Can we doubt that the loves and feats of Jupiter Genitor (not forgetting the white bull of Europa), and his extraordinary title of Lapis, for which no satisfactory reason is commonly given, have a connection with the Indian philosophy and mythology?

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SIUM, WATER PARSNEP, a genus of plants belonging to the class of *pentandria*, and order of *digynia*, and in the natural system ranging under the 44th order, *Umbellatæ*. See BOTANY *Index*.

SIWA, or SIWAH, a town in Egypt to the westward of Alexandria, built on a small fertile spot, surrounded on all sides by desert land. A considerable portion of this space is filled with date trees, but there are also plantains, pomegranates, figs, apricots, and olives; and the gardens are in a very flourishing condition. The people cultivate rice, which is of a reddish colour, and different from that of the delta. The rest of the land furnishes abundance of wheat for the consumption of the inhabitants.

The greatest curiosity about Siwa is a ruin of undoubted antiquity, measuring 32 feet in length, 18 in height, and 15 in breadth, which does not appear ever to have been much larger. Mr Horneman estimates the dimensions of it at 36 feet long, 24 feet wide, and 27 high, which agrees with no other traveller whatever; and indeed Mr Horneman himself allows that the jealousy of the natives prevented him from pursuing any plan of accurate examination or admeasurement. The people of Siwa have no tradition respecting this edifice, nor attribute any quality to it, but that of concealing treasures, and as the haunt of demons. It has, however, been supposed, that Siwa is the *Siropum* of Pliny, and that this building was coeval with the temple of Jupiter Ammon, and a dependency on it; yet neither the natives of Siwa, nor the various tribes of Arabs who frequent that place, know any thing of the ruins of that temple, about which Mr Browne made every possible enquiry.

The complexion of the people of Siwa is generally darker than that of the Egyptians, and their dialect is also different. They do not habitually make use of snuff or tobacco. Their sect is that of Malik. The dress of the lower class is very simple, as they are almost naked; among those whose costume was discernible, it approaches nearer to that of the Arabs of the desert than the Egyptians or Moors. Their clothing consists of a shirt of white cotton, with large sleeves reaching to the feet, a red cap without a turban, and shoes of the same colour. Some earthen ware made by themselves, and a few mats, form the chief part of their household furniture, none but the higher ranks being possessed of copper utensils. They sometimes purchase a few slaves from the Mourzouk caravan. The rest of their wants are supplied from Cairo or Alexandria, whither their dates are transported, both in a dry state, and beaten into mash, which, when good, greatly resembles a sweetmeat. They do not eat large quantities of animal food, and bread known to us is uncommon. They drink plentifully of the liquor extracted from the date tree, which they call *date-tree water*, though it has frequently the power of inebriating in the state in which they drink it. Their animals are the hairy sheep and goat of Egypt, the ass, and a very small number of oxen and camels. The women wear veils as in Egypt. After the rains, the ground in the vicinity of Siwa is covered with salt for many weeks.

Siwa has sometimes been compared to a bee-hive, which it very much resembles, whether in respect to the general appearance of the eminence covered with buildings, the swarm of its people crowded together, or the confused noise, or hum and buzz from its narrow passages and streets, and which reach the ear at a considerable distance. North-west of the town there is a stratum of salt extending a full mile, and near it salt is found on the surface. There are numerous springs, and frequently a spring of water perfectly sweet is found within a few paces of one that is salt. The people, according to Horneman, are obtrusive and thievish. Siwa is situated in 29° 12′ N. Lat. and 44° 54′ E. Long.

SIX-CLERKS, officers in chancery of great account, next in degree below the twelve masters, whose business it is to enrol commissions, pardons, patents, warrants, &c. which pass the great seal, and to transact and file all proceedings by bill, answer, &c. They were anciently *clerici*, and forfeited their places, if they married; but when the constitution of the court began to alter, a law was made to permit them to marry, Stat. 14. and 15. Hen. VIII. cap. 8. They are also solicitors for parties in suits depending in the court of chancery. Under them are six deputies and 60 clerks, who, with the under clerks, do the business of the office.

SIX NATIONS. See NIAGARA.

SIXTH, in *Music*, one of the simple original concords, or harmonical intervals. See INTERVAL.

SIXTUS V. POPE, was born the 13th December, 1521, in La Marca, a village in the seigniory of Montalto. His father, Francis Peretti, was a gardener, and his mother a servant maid. He was their eldest child, and was called Felix. At the age of nine he was hired out to an inhabitant of the village to keep sheep; but disobliging his master, he was soon after degraded to be keeper of the hogs. He was engaged in this employment when Father Michael Angelo Selleri, a Franciscan friar, asked the road to Ascoli, where he was going to preach. Young Felix conducted him thither, and struck the father so much with his conversation and eagerness for knowledge, that he recommended him to the fraternity to which he had come. Accordingly he was received among them, invested with the habit of a lay brother, and placed under the sacristan, to assist in sweeping the church, lighting the candles, and other offices of that nature; for which he was to be taught the responses, and the rudiments of grammar. His progress in learning was so surprising, that at the age of 14 he was thought qualified to begin his noviciate, and was admitted the year following to make his profession.

He pursued his studies with such unwearied assiduity, that he was soon reckoned equal to the best disputants. He was ordained priest in 1545, when he assumed the name of Father Montalto; soon after he took his doctor's degree, and was appointed professor of theology at Sienna. It was then that he so effectually recommended himself to Cardinal di Carpi, and his secretary Bossius, that they ever remained his steady friends. Meanwhile the severity and obstinacy of his temper incessantly engaged him in disputes with his monastic brethren. His reputation for eloquence, which was now spread over Italy, about this time gained him some new friends. Among these were the Colonna family, and Father Ghisilieri, by whose recommendation he was appointed inquisitor-general at Venice: but he exercised that office with so much severity, that he was obliged to flee precipitately from that city. Upon this he went to Rome, where he was made procurator-general of his order, and soon after accompanied Cardinal Buon Compagnon into Spain, as a chaplain and consultor to the inquisition. There he was treated with great respect, and liberal offers were made him to induce him to continue in Spain, which, however, he could not be prevailed on to accept.

In the mean time, news were brought to Madrid that Pius IV. was dead. and that Father Ghisilieri, who had been made Cardinal Alexandrino by Paul IV. had succeeded him under the name of Pius V. These tidings filled Montalto with joy, and not without reason, for he was immediately invested by the pontiff with new dignities. He was made general of his order, bishop of St Agatha, was soon after raised to the dignity of cardinal, and received a pension. About this time he was employed by the pope to draw up the bill of excommunication against Queen Elizabeth.

He began now to cast his eyes upon the papacy; and, in order to obtain it, formed and executed a plan of hypocrisy with unparalleled constancy and success. He became humble, patient, and affable. He changed his dress, his air, his words, and his actions, so completely, that his most intimate friends declared him a new man. Never was there such an absolute victory gained over the passions; never was a fictitious character so long maintained, nor the foibles of human nature so artfully concealed. He courted the ambassadors of every foreign power, but attached himself to the interests of none; nor did he accept a single favour that would have laid him under any peculiar obligation. He had formerly treated his relations with the greatest tenderness, but he now changed his behaviour altogether. When his brother Anthony came to visit him, he lodged him in an inn, and sent him home next day, charging him to inform his family that he was now dead to his relations and the world.

When Pius V. died in 1572, he entered the conclave with the other cardinals, but seemed altogether indifferent about the election, and never left his apartment except to his devotion. When solicited to join any party, he declined it, declaring that he was of no consequence, and that he would leave the choice of a pope entirely to persons of greater knowledge and experience. When Cardinal Buon Compagnon, who assumed the name of Gregory XIII. was elected, Montalto assured him that he never wished for any thing so much in his life, and that he would always remember his goodness, and the favours he had conferred on him in Spain. But the new pope treated him with the greatest contempt, and deprived him of his pension. The cardinals also, deceived by his artifices, paid him no greater respect, and used to call him, by way of ridicule, the Roman beast; the ass of La Marca.

He now assumed all the infirmities of old age; his head hung down upon his shoulders; he tottered as he walked, and supported himself on a staff. His voice became feeble, and was often interrupted by a cough so exceedingly severe, that it seemed every moment to threaten his dissolution. He interfered in no public transactions, but spent his whole time in acts of devotion and benevolence. Mean time he constantly employed the ablest spies, who brought him intelligence of every particular.

When Gregory XIII. died in 1585, he entered the conclave with the greatest reluctance, and immediately shut himself up in his chamber, and was no more thought of than if he had not existed. When he went to

Sixtus. to mafs, for which purpofe alone he left his apartment, he appeared perfectly indifferent about the event of the election. He joined no party, yet flattered all.

He knew early that there would be great divifions in the conclave, and he was aware that when the leaders of the different parties were difappointed in their own views, they all frequently agreed in the election of fome old and infirm cardinal, the length of whofe life would merely enable them to prepare themfelves fufficiently for the next vacancy. Thefe views directed his conduct, nor was he miftaken in his hopes of fuccefs.

Three cardinals, the leaders of oppofite factions, being unable to procure the election which each of them wifhed, unanimoufly agreed to make choice of Montalto. When they came to acquaint him with their intention, he fell into fuch a violent fit of coughing that every perfon thought he would expire on the fpot. He told them that his reign would laft but a few days; that, befides a continual difficulty of breathing, he wanted ftrength to fupport fuch a weight, and that his fmall experience rendered him very unfit for fo important a charge. He conjured them all three not to abandon him, but to take the whole weight of affairs upon their own fhoulders; and declared that he would never accept the mitre upon any other terms: "If you are refolved," added he, "to make me pope, it will only be placing yourfelves on the throne. For my part, I fhall be fatisfied with the bare title. Let the world call me pope, and I make you heartily welcome to the power and authority. The cardinals fwallowed the bait, and exerted themfelves fo effectually that Montalto was elected. He now pulled off the mafk which he had worn for 14 years. No fooner was his election fecured, than he ftarted from his feat, flung down his ftaff in the middle of the hall, and appeared almoft a foot taller than he had done for feveral years.

When he was afked, according to cuftom, if he would accept of the papacy, he replied, "It is trifling to afk whether I will accept what I have already accepted.— However, to fatisfy any fcruple that may arife, I tell you that I accept it with great pleafure, and would accept another if I could get it; for I find myfelf able, by the Divine affiftance, to manage two papacies." His former complaifance and humility difappeared, together with his infirmities, and he now treated all around him with referve and haughtinefs. The firft care of Sixtus V. the name which Montalto affumed, was to correct the abufes, and put a ftop to the enormities, which were daily committed in every part of the ecclefiaftical ftate. The lenity of Gregory's government had introduced a general licentioufnefs of manners, which burft forth with great violence, after that pontiff's death. It had been ufual with former popes to releafe delinquents on the day of their coronation, who were therefore accuftomed to furrender themfelves voluntary prifoners immediately after the election of the pope. At prefent, however, they were fatally difappointed.— When the governor of Rome and the keeper of St Angelo waited on his Holinefs, to know his intention in this particular, he replied, "What have you to do with pardons, and releafing of prifoners? Is it not fufficient that our predeceffor has fuffered the judges to remain unemployed thefe 13 years? Shall we alfo ftain our pontificate with the fame neglect of juftice? We have too long feen, with inexpreffible concern, the prodigious degree of wickednefs that reigns in the ftate, to think of granting pardons. Let the prifoners be brought to a fpeedy trial, and punifhed as they deferve, to fhow the world that Divine Providence has called us to the chair of St Peter, to reward the good, and chaftife the wicked: that we bear not the fword in vain, but are the minifters of God, and a revenger to execute wrath on them that do evil."

He appointed commiffioners to infpect the conduct of the judges, difplaced thofe who were inclined to lenity, and put others of fevere difpofitions in their room. He offered rewards to any perfon who could convict them of corruption or partiality. He ordered the fyndics of all the towns and figniories to make out a complete lift of the diforderly perfons within their diftricts, and threatened the ftrapado for the fmalleft omiffion. In confequence of this edict, the fyndic of Albino was fcourged in the market place, becaufe he had left his nephew, an incorrigible libertine, out of his lift.

He made very fevere laws againft robbers and affaffins. Adulterers, when difcovered, fuffered death; and they who willingly fubmitted to the proftitution of their wives, a cuftom then common in Rome, received the fame punifhment. He was particularly careful of the purity of the female fex, and never forgave thofe who attempted to debauch them.

His execution of juftice was as prompt as his edicts were rigorous. A Swifs happening to give a Spanifh gentleman a blow with his halberd, was ftruck by him fo rudely with a pilgrim's ftaff that he expired on the fpot. Sixtus informed the governor of Rome that he was to dine early, and that juftice muft be executed on the criminal before he fat down to table. The Spanifh ambaffador and four cardinals intreated him not to difgrace the gentleman by fuffering him to die on a gibbet, but to order him to be beheaded. "He fhall be hanged (replied Sixtus), but I will alleviate his difgrace by doing him the honour to affift perfonally at his death." He ordered a gibbet to be erected before his own windows, where he continued fitting during the whole execution. He then called to his fervants to bring in dinner, declaring that the act of juftice which he had juft feen had increafed his appetite. When he rofe from table, he exclaimed, "God be praifed for the good appetite with which I have dined!"

When Sixtus afcended the throne, the whole ecclefiaftical ftate was infefted with bands of robbers, who from their numbers and outrages, were exceedingly formidable; by his prudent and vigorous conduct, however, he in a fhort time extirpated the whole of thefe banditti.

Nor was the vigour of his conduct lefs confpicuous in his tranfactions with foreign nations. Before he had been pope two months he quarrelled with Philip II. of Spain, Henry III. of France, and Henry king of Navarre. His intrigues indeed in fome meafure influenced all the councils of Europe.

After his acceffion to the pontificate he fent for his family to Rome, with exprefs orders that they fhould appear in a decent and modeft manner. Accordingly, his fifter Camilla came thither, accompanied by her daughter and two grandchildren. Some cardinals, in order to pay court to the pope, went out to meet her, and introduced her in a very magnificent drefs. Sixtus pretended not to know her, and afked two or three times

Sixtus.

times who she was: Upon this one of the cardinals said, "It is your sister, holy father." "I have but one sister (replied Sixtus with a frown), and she is a poor woman at Le Grotte; if you have introduced her in this disguise, I declare I do not know her; yet I think I would know her again, if I saw her in the clothes she used to wear."

Her conductors at last found it necessary to carry her to an inn, and strip her of her finery. When Camilla was introduced a second time, Sixtus embraced her tenderly, and said, "Now we know indeed that it is our sister: nobody shall make a princess of you but ourselves." He stipulated with his sister, that she should neither ask any favour in matters of government, nor intercede for criminals, nor interfere in the administration of justice; declaring that every request of that kind would meet with a certain refusal. These terms being agreed to, and punctually observed, he made the most ample provision not only for Camilla but for his whole relations.

This great man was also an encourager of learning. He caused an Italian translation of the Bible to be published, which raised a good deal of discontent among the Catholics. When some cardinals reproached him for his conduct in this respect, he replied, "It was published for the benefit of you cardinals who cannot read Latin."

Sixtus died in 1590, after having reigned little more than five years. His death was ascribed to poison, said to have been administered by the Spaniards; but the story seems rather improbable.

It was to the indulgence of a disposition naturally formed for severity, that all the defects of this wonderful man are to be ascribed. Clemency was a stranger to his bosom; his punishments were often too cruel, and seemed sometimes to border on revenge. Pasquin was dressed one morning in a very nasty shirt, and being asked by Marforio why he wore such dirty linen? replied, that he could get no other, for the pope had made his washerwoman a princess, alluding to Camilla, who had formerly been a laundress. The pope ordered strict search to be made for the author of this lampoon, and offered him his life and a thousand pistoles if he would discover himself. The author was simple enough to make his appearance and claim the reward. "It is true (said the pope) we made such a promise, and we shall keep it; your life shall be spared, and you shall receive the money presently: but we have reserved to ourselves the power of cutting off your hands and boring your tongue through, to prevent your being so witty for the future." It is needless to add, that the sentence was immediately executed. This, however, is the only instance of his resenting the many severe satires that were published against him.

But though the conduct of Sixtus seldom excites love, it generally commands our esteem, and sometimes our admiration. He strenuously defended the cause of the poor, the widow, and the orphan: he never refused audience to the injured, however wretched or forlorn their appearance was. He never forgave those magistrates who were capable of partiality or corruption; nor suffered crimes to pass unpunished, whether committed by the rich or the poor. He was frugal, temperate, sober, and never neglected to reward the smallest favour which had been conferred on him before his exaltation.

Sixtus, Sizar.

When he mounted the throne, the treasury was not only exhausted, but in debt: at his death it contained five millions of gold.

Rome was indebted to him for several of her greatest embellishments, particularly the Vatican library: it was by him, too, that trade was first introduced into the Ecclesiastical State.

SIYA-GHUSH, the caracal of Buffon, an animal of the cat kind. See FELIS, MAMMALIA *Index*.

SIZAR, or SIZER, in Latin *Sizator*, an appellation by which the lowest order of students in the universities of Cambridge and Dublin are distinguished, is derived from the word *size*, which in Cambridge, and probably in Dublin likewise, has a peculiar meaning. To *size*, in the language of the university, is to get any sort of victuals from the kitchens, which the students may want in their own rooms, or in addition to their commons in the hall, and for which they pay the cooks or butchers at the end of each quarter. A size of any thing is the smallest quantity of that thing which can be thus bought: two sizes, or a part of beef, being nearly equal to what a young person will eat of that dish to his dinner; and a size of ale or beer being equal to half an English pint.

The sizars are divided into two classes, viz. subsizatores or sizars, and sizatores or proper sizars. The former of these are supplied with commons from the table of the fellows and fellow commoners; and in former times, when these were more scanty than they are now, they were obliged to supply the deficiency by sizing, as is sometimes the case still. The proper sizars had formerly no commons at all, and were therefore obliged to size the whole. In St John's college they have now some commons allowed them for dinner, from a benefaction, but they are still obliged to size their suppers: in the other colleges they are allowed a part of the fellow-commons, but must size the rest; and from being thus obliged to size the whole or part of their victuals, the whole order derived the name of *sizars*.

In Oxford, the order similar to that of sizar is denominated *servitor*, a name evidently derived from the menial duties which they perform. In both universities these orders were formerly distinguished by round caps and gowns of different materials from those of the pensioners or commoners, the order immediately above them. But about 30 years ago the round cap was entirely abolished in both seminaries. There is still, however, in Oxford, we believe, a distinction in the gowns, and there is also a trifling difference in some of the small colleges in Cambridge; but in the largest colleges the dress of the pensioners and sizars is entirely the same.

In Oxford, the servitors are still obliged to wait at table on the fellows and gentlemen-commoners; but much to the credit of the university of Cambridge, this most degrading and disgraceful custom was entirely abolished about 10 or 12 years ago, and of course the sizars of Cambridge are now on a much more respectable footing than the servitors of Oxford.

The sizars are not upon the foundation, and therefore while they continue sizars are not capable of being elected

elected fellows; but they may at any time, if they choose, become pensioners: and they generally sit for scholarships immediately before they take their first degree. If successful, they are then on the foundation, and are entitled to become candidates for fellowships when they have got that degree. In the mean time, while they continue sizars, besides free commons they enjoy many benefactions, which have been made at different times, under the name of *sizar's prætor*, *exhibitions*, &c. and the rate of tuition, the rent of rooms, and other things of that sort within their respective colleges, is less than to the other orders. But though their education is thus obtained at a less expence, they are not now considered as a menial order; for sizars, pensioner-scholars, and even sometimes fellow-commoners, mix together with the utmost cordiality. It is worthy of remark, that at every period this order has supplied the university with its most distinguished officers; and that many of the most illustrious members of the church, many of the most distinguished men in the other liberal professions, have, when under-graduates, been sizars, when that order was on a less respectable footing than it is now.

SIZE, the name of an instrument used for finding the bigness of fine round pearls. It consists of thin pieces or leaves, about two inches long, and half an inch broad, fastened together at one end by a rivet. In each of these are round holes drilled of different diameters. Those in the first leaf serve for measuring pearls from half a grain to seven grains; those of the second, for pearls from eight grains or two carats to five carats, &c.; and those of the third, for pearls from six carats and a half to eight carats and a half.

SIZE, is also a sort of paint, varnish, or glue, used by painters, &c.

The shreds and parings of leather, parchment, or vellum, being boiled in water and strained, make size. This substance is much used in many trades.—The manner of using size is to melt some of it over a gentle fire; and scraping as much whiting into it as will just colour it, let them be well incorporated together; after which you may whiten frames, &c. with it. After it dries, melt the size again, and put more whiting, and whiten the frames, &c. seven or eight times, letting it dry between each time: but before it is quite dry, between each washing with size, you must smooth and wet it over with a clean brush-pencil in fair water.

To make gold-size. Take gum-anime and asphaltum, of each one ounce; minium, litharge of gold, and amber, of each half an ounce: reduce all into a very fine powder, and add to them four ounces of linseed oil, and eight ounces of drying oil: digest them over a gentle fire that does not flame, so that the mixture may only simmer, but not boil; lest it should run over and set the house on fire, stir it constantly with a stick till all the ingredients are dissolved and incorporated, and do not leave off stirring till it becomes thick and ropy; after being sufficiently boiled, let it stand till it is almost cold, and then strain it through a coarse linen cloth, and keep it for use.—To prepare it for working, put what quantity you please in a horse-muscle shell, adding as much oil of turpentine as will dissolve it; and making it as thin as the bottom of your shell-like varnish, hold it over a candle, and then strain it through a linen-rag into another shell; add to these as much vermilion as will make it of a darkish red: if it is too thick for drawing, you may thin it with some oil of turpentine. The chief use of this size is for laying on metals.

The best gold size for burnishing is made as follows: Take fine bole, what quantity you please; grind it finely on a piece of marble, then scrape into it a little beef suet; grind all well together; after which mix in a small proportion of parchment-size with a double proportion of water, and it is done.

To make silver-size. Take tobacco-pipe clay in fine powder, into which scrape some black-lead and a little Genoa soap, and grind them all together with parchment size as already directed.

SKATING, an exercise on ice, both graceful and healthy. Although the ancients were remarkable for their dexterity in most of the athletic sports, yet skating seems to have been unknown to them. It may therefore be considered as a modern invention; and probably it derived its origin in Holland, where it was practised, not only as a graceful and elegant amusement, but as an expeditious mode of travelling when the lakes and canals were frozen up during winter. In Holland long journeys are made upon skates with ease and expedition; but in general less attention is there paid to graceful and elegant movements, than to the expedition and celerity of what is called *journey skating*. It is only in those countries where it is considered as an amusement, that its graceful attitudes and movements can be studied; and there is no exercise whatever better calculated to set off the human figure to advantage. The acquirement of most exercises may be attained at an advanced period of life; but to become an expert skater, it is necessary to begin the practice of the art at a very early age. It is difficult to reduce the art of skating to a system. It is principally by the imitation of a good skater that a young practitioner can form his own practice. The English, though often remarkable for feats of agility upon skates, are very deficient in gracefulness; which is partly owing to the construction of the skates. They are too much curved in the surface which embraces the ice, consequently they involuntarily bring the users of them round on the outside upon a quick and small circle; whereas the skater, by using skates of a different construction, less curved, has the command of his stroke, and can enlarge or diminish the circle according to his own wish and desire. The metropolis of Scotland has produced more instances of elegant skaters than perhaps any other country whatever; and the institution of a skating club about 50 years ago, has contributed not a little to the improvement of this elegant amusement. We are indebted for this article to a gentleman of that club, who has made the practice and improvement of skating his particular study; and as the nature of our work will not permit the insertion of a full treatise on skating, we shall present our readers with a few instructions.

Those who wish to be proficients should begin at an early period of life; and should first endeavour to throw off the fear which always attends the commencement of an apparently hazardous amusement. They will soon acquire a facility of moving on the inside: when they have done this, they must endeavour to acquire the movement on the outside of the skate; which is nothing more than throwing themselves upon the outer edge of the skate, and making the balance of their body tend

towards

towards that ſide, which will neceſſarily enable them to form a ſemicircle. In this, much aſſiſtance may be derived from placing a bag of lead-ſhot in the pocket next to the foot employed in making the outſide ſtroke, which will produce an artificial poiſe of the body, which afterwards will become natural by practice. At the commencement of the outſide ſtroke, the knee of the employed limb ſhould be a little bended, and gradually brought to a rectilineal poſition when the ſtroke is completed. When the practitioner becomes expert in forming the ſemicircle with both feet, he is then to join them together, and proceed progreſſively and alternately with both feet, which will carry him forward with a graceful movement. Care ſhould be taken to uſe very little muſcular exertion, for the impelling motion ſhould proceed from the mechanical impulſe of the body thrown into ſuch a poſition as to regulate the ſtroke. At taking the outſide ſtroke, the body ought to be thrown forward eaſily, the unemployed limb kept in a direct line with the body, and the face and eyes directly looking forward: the unemployed foot ought to be ſtretched towards the ice, with the toes in a direct line with the leg. In the time of making the curve, the body muſt be gradually, and almoſt imperceptibly, raiſed, and the unemployed limb brought in the ſame manner forward; ſo that, at finiſhing the curve, the body will bend a ſmall degree backward, and the unemployed foot will be about two inches before the other, ready to embrace the ice and form a correſpondent curve. The muſcular movement of the whole body muſt correſpond with the movement of the ſkate, and ſhould be regulated ſo as to be almoſt imperceptible to the ſpectators. Particular attention ſhould be paid in carrying round the head and eyes with a regular and imperceptible motion; for nothing ſo much diminiſhes the grace and elegance of ſkating as ſudden jerks and exertions, which are too frequently uſed by the generality of ſkaters. The management of the arms likewiſe deſerves attention. There is no mode of diſpoſing of them more gracefully in ſkating outſide, than folding the hands into each other, or uſing a muff.

There are various feats of activity and manœuvres uſed upon ſkates; but they are ſo various that we cannot pretend to detail them. Moving on the outſide is the primary object for a ſkater to attain; and when he becomes an adept in that, he will eaſily acquire a facility in executing other branches of the art. There are few exerciſes but will afford him hints of elegant and graceful attitudes. For example, nothing can be more beautiful than the attitude of drawing the bow and arrow whilſt the ſkater is making a large circle on the outſide: the manual exerciſe and military ſalutes have likewiſe a pretty effect when uſed by an expert ſkater.

SKELETON, in *Anatomy*, the dried bones of any animal joined together by wires, or by the natural ligament dried, in ſuch a manner as to ſhow their poſition when the creature was alive.

We have, in the Philoſophical Tranſactions, an account of a human ſkeleton, all the bones of which were ſo united, as to make but one articulation from the back to the os ſacrum, and downwards a little way. On ſawing ſome of them, where they were unnaturally joined, they were found not to cohere throughout their whole ſubſtance, but only about a ſixth of an inch deep all round. The figure of the trunk was crooked, the ſpinæ making the convex, and the inſide of the vertebræ the concave part of the ſegment. The whole had been found in a charnel-houſe, and was of the ſize of a full grown perſon.

SKIDS, or SKEEDS, in ſea-language, are long compaſſing pieces of timber, notched below ſo as to fit cloſely upon the wales, extending from the main-wale to the top of the ſide, and retained in this poſition by bolts or ſpike-nails. They are intended for preſerving the planks of the ſide, when any heavy body is hoiſted or lowered.

SKIE, ISLE OF. See SKYE.

SKIFF, a ſmall boat reſembling a yawl, uſually employed for paſſing rivers.

SKIMMER, BLACK. See RHYNCHOPS, ORNITHOLOGY *Index*.

SKIMMIA, a genus of plants belonging to the tetrandria claſs; and in the natural method ranking under the 40th order, *Perſonatæ*. See BOTANY *Index*.

SKIN, in *Anatomy*, the general covering of the body of any animal. See ANATOMY, N° 74.

SKIN, in *Commerce*, is particularly uſed for the membrane ſtripped off the animal to be prepared by the tanner, ſkinner, parchment-maker, &c. and converted into leather, &c. See TANNING.

SKINNER, STEPHEN, an Engliſh antiquarian, was born in 1622. He travelled, and ſtudied in ſeveral foreign univerſities during the civil wars; and in 1654, returned and ſettled at Lincoln, where he practiſed phyſic with ſucceſs until the year 1667, when he died of a malignant fever. His works were collected in folio in 1671, by Mr Henſhaw, under the title of *Etymologicon Linguæ Anglicanæ*, &c.

SKIPPER, or SAURY, a ſpecies of fiſh. See ESOX, ICHTHYOLOGY *Index*.

SKIRMISH, in *War*, a ſlight engagement between ſmall parties, without any regular order; and is therefore eaſily diſtinguiſhed from a *battle*, which is a general engagement between two armies continued for ſome time.

SKIRMISH Bay, the name given by Lieutenant Broughton to a bay in an iſland which was diſcovered by him in latitude 43° 48′ ſouth, and in longitude 183° eaſt. The Chatham armed tender worked up into the bay, and came to anchor about a mile from the ſhore. When the captain and ſome of the people landed, they found the natives ſo extremely inhoſpitable, that ſelf-preſervation made it neceſſary to fire upon them. The land is of conſiderable magnitude, whether iſland or continent, and what they ſaw of it extended nearly 40 miles from eaſt to weſt, and the appearance of the country they regarded as very promiſing. The natives reſemble thoſe of New Zealand, from which they are diſtant about 100 leagues, but their ſkins were deſtitute of any marks, and they ſeemed to be cleanly in their perſons. Their dreſſes were of ſeal ſkin, while ſome had fine mats faſtened round the waiſt. Mr Broughton ſays, "on our firſt landing, their ſurpriſe and exclamations can hardly be imagined; they pointed to the ſun, and then to us, as if to aſk whether we had come from thence?" The arms they made uſe of were clubs, ſpears, and a ſmall weapon reſembling the patoo of New Zealand.

SKULL, in *Anatomy*, the bony caſe in which the brain is encloſed. See ANATOMY, N° 11, &c.

Skull || Skye.

SKULL-Cap. See SCUTELLARIA, BOTANY *Index*.

SKY, the blue expanfe of air or atmofphere. For the reafon of its blue colour and concave figure, fee OPTICS, N° 223.

SKYE, one of the greateft of the Weftern iflands of Scotland, fo called from *Skianach*, which in the Erfe dialect fignifies *winged*, becaufe the two promontories of Valernefs and Toternifh, by which it is bounded on the north-weft and north-eaft, are fuppofed to refemble wings. The ifland lies between the fhire of Rofs and the weftern part of Lewis. According to the computation of Mr Pennant, Dr Johnfon, and Dr Campbell, it is 60 miles in length, and nearly the fame in width where broadeft; according to others it is 50 miles in length, and in fome places 30 broad. The ifland of Skye was formerly divided between two proprietors; the fouthern part belonged to the laird of Macleod, faid to be lineally defcended from Leod fon to the black prince of Man, but part of this divifion has fallen into other hands: the northern diftrict is the property of Lord Macdonald, whofe anceftor was Donald, king or lord of the ifles, and chief of the numerous clan of Macdonalds, who are counted the moft warlike of all the Highlanders. Skye is part of the fhire of Invernefs, and formerly belonged to the diocefe of the Ifles: on the fouth it is parted from the main land by a channel three leagues in breadth; though, at the ferry of Glenelg, it is fo narrow that a man may be heard calling for the boat from one fide to the other. Skye is well provided with a variety of excellent bays and harbours.

The face of the country is roughened with mountains, fome of which are fo high as to be covered with fnow on the top at midfummer; in general, their fides are clothed with heath and grafs, which afford good pafturage for fheep and black cattle. Between the mountains there are fome fertile valleys, and the greater part of the land towards the fea-coaft is plain and arable. The ifland is well watered with a great number of rivers, above 30 of which afford falmon; and fome of them produce black mufcles in which pearls are bred, particularly the rivers Kilmartin and Ord: Martin was affured by the proprietor of the former, that a pearl hath been found in it valued at 20l. Sterling. Here is alfo a confiderable number of frefh-water lakes well ftored with trout and eels. The largeft of thefe lakes takes its denomination from St Columba, to whom is dedicated a chapel that ftands upon a fmall ifle in the middle of the lake. Skye likewife affords feveral cataracts, that roar down the rocks with great impetuofity. That the ifland has been formerly covered with woods, appears from the large trunks of fir and other trees daily dug out of the bogs and peat-marfhes in every part of the country.

Statiftical Account of Scotland, vol. xvi. p. 140.

From the height of the hills, and proximity of the fea, the air feldom continues long of the fame temperature; fometimes it is dry, oftener moift, and in the latter end of winter and beginning of fpring cold and piercing; at an average, three days in twelve throughout the year fcarcely free from rain, far lefs from clouds. Thefe, attracted by the hills, fometimes break in ufeful and refrefhing fhowers; at other times fuddenly burfting, pour down their contents with tremendous noife, in impetuous torrents that deluge the plains below, and render the fmalleft rivulet impaffable; which, together with the ftormy winds fo common in this country in the months of Auguft and September, frequently blaft the hopes, and difappoint the expectations, of the hufbandman. Snow has been often known to lie on the ground from three to feven weeks; and on the higheft hills, even in the middle of June, fome fpots of it are to be feen. To this various temperature of the air, and uncertainty of weather, the fevers and agues, headachs, rheumatifms, colds, and dyfenteries, which are the prevailing diftempers, may be afcribed. That it is far, however, from being unwholefome, is fufficiently evinced by experience; for the inhabitants are, in general, as ftrong and healthy, and arrive at as advanced an age, as thofe who live in milder climates, and under a ferener fky. The gout is fcarcely known in this ifland.

Skye.

The foil is generally black, though it likewife affords clay of different colours; fuch as white, red, and blue, and in fome places fuller's earth. It is, however, much lefs adapted for agriculture than for pafture, and feldom, unlefs, in very good years, fupplies itfelf with a fufficiency of provifions. Yet, though the foil is not very fertile or rich, it might with proper management be made to produce more plentiful crops. But the generality of the farmers are fo prejudiced in favour of old cuftoms, and indeed fo little inclined to induftry, that they will not eafily be prevailed on to change them for better; efpecially if the alteration or amendment propofed be attended with expence. Therefore, with refpect to improvements in agriculture, they are ftill much in the fame ftate as they were 20 or 30 years ago. Ploughs, on a new and improved model, that in comparifon to the advantages derived from them might be had at a moderate expence, have lately been introduced into feveral diftricts around, where their good effects are manifeft in improving the crops and diminifhing the labour of man and beaft; but the laird of Raafay and one other gentleman are the only perfons in Portree that have ufed them. The *cafcroim*, a crooked kind of fpade, is almoft the only inftrument for labouring the ground ufed among the ordinary clafs of tenants. The average crops of corn are 8000 bolls.

When Mr Knox vifited this ifland in 1786, the number of inhabitants amounted to 15,000: but between 1790-98, according to the Statiftical Hiftory of Scotland, the population is only 14,470.

Various minerals are found in Skye, but none have been wrought to any advantage. Near the village of Sartle, the natives find black and white marcafites, and variegated pebbles. The Applefglen, in the neighbourhood of Lochfallart, produces beautiful agates of different colours: ftones of a purple hue are, after great rains, found in the rivulets: cryftal, of different colours and forms, abounds in feveral parts of the ifland, as well as black and white marble, free-ftone, lime-ftone, and talc: fmall red and white coral is found on the fouthern and weftern coafts in great abundance. The fuel confifts chiefly of peat and turf, which are impregnated with iron ore; and coal has been difcovered in feveral diftricts; but it does not appear to be worth working.

The wild birds of all forts moft common in the country, are, folan geefe, gulls, cormorants, cranes, wild geefe, and wild ducks; eagles, crows, ravens, rooks, cuckoos, rails, woodcocks, moor-fowl, partridges, plover, wild pigeons, and blackbirds, owls, hawks, fnipes, and a variety of ſmall birds. In mild ſeaſons, the cuckoo and rail appear in the latter end of April; the former diſappears always before the end of June; the latter ſometimes not till September. The woodcock comes in October, and frequently remains till March. The tame ſorts of fowl are geeſe, ducks, turkeys, cocks, pullets, and tame pigeons.

The black cattle are here expoſed to all the rigours of the ſevere winter, without any other provender than the tops of the heath and the alga marina; ſo that they appear like mere ſkeletons in the ſpring; though, as the graſs grows up, they ſoon become plump and juicy, the beef being ſweet, tender, and finely interlarded.—The amphibious animals are ſeals and otters. Among the reptiles may be reckoned vipers, aſps, frogs, toads, and three different kinds of ſerpents; the firſt ſpotted black and white, and very poiſonous; the ſecond yellow, with brown ſpots; and the third of a brown colour, the ſmalleſt and leaſt poiſonous.

Whales, and cairbans or ſun-fiſh, come in ſometimes to the ſounds after their prey, but are rarely purſued with any ſucceſs. The fiſhes commonly caught on the coaſt are herrings, ling, cod, ſkate, haddock, mackerel, lythe, ſye, and dog-fiſh. The average price of ling at home is 13l. 13s. per ton; when ſold, one by one, if freſh, the price is from 3d. to 5d.; if cured, from 5d. to 7d. The barrel of herrings ſeldom ſells under 19s. which is owing to the great difficulty of procuring ſalt, even ſometimes at any price; and the ſame cauſe prevents many from taking more than are ſufficient for their own uſe.

The kyle of Scalpe teems with oyſters, in ſuch a manner, that after ſome ſpring-tides, 20 horſe-loads of them are left upon the ſands. Near the village of Bernſtill, the beach yields muſcles ſufficient to maintain 60 perſons per day; this providential ſupply helps to ſupport many poor families in times of ſcarcity.

The people are ſtrong, robuſt, healthy, and prolific. They generally profeſs the Proteſtant religion; are honeſt, brave, innocent, and hoſpitable. They ſpeak the language, wear the habit, and obſerve the cuſtoms that are common to all the Hebrides. The meconium in new-born infants is purged away with freſh butter: the children are bathed every morning and evening in water, and grow up ſo ſtrong, that a child of 10 months is able to walk alone: they never wear ſhoes or ſtockings before the age of eight or ten, and night-caps are hardly known; they keep their feet always wet; they lie on beds of ſtraw or heath, which laſt is an excellent reſtorative: they are quick of apprehenſion, ingenious, and very much addicted to muſic and poetry. They eat heartily of fiſh; but ſeldom regale themſelves with fleſh-meat: their ordinary food conſiſts of butter, cheeſe, milk, potatoes, colewort, brochan, and a diſh called *oon*, which indeed is no other than the froth of boiled milk or whey raiſed with a ſtick like that uſed in making chocolate.

A ſort of coarſe woollen cloth called *cloa*, or *caddoes*, the manufacture of their wives, made into ſhort jackets and trouſers, is the common dreſs of the men. The philibeg is rarely worn, except in ſummer and on Sundays; on which days, and ſome other occaſions, thoſe in better circumſtances appear in tartans, a bonnet, and ſhort hoſe, and ſome in a hat, ſhort coat, waiſtcoat, and breeches, of Scotch or Engliſh manufacture. The women are in general very cleanly, and ſo exceſſively fond of dreſs, that many maid-ſervants are often known to lay out their whole wages that way.

There are two fairs held annually at Portree, to which almoſt every part of Sky ſends cattle. The firſt is held in the end of May, and the ſecond in the end of July. The fair commonly continues from Wedneſday till the Saturday following. The commodities which are ſold in theſe are horſes, cows, ſheep, goats, hides, butter, cheeſe, fiſh, and wool. The cattle ſold in theſe fairs ſwim over to the main land through a mile or half a mile of ſea. Thouſands of theſe are yearly exported, at from 2l. to 3l. each. Many of them are driven to England, where they are fatted for the market, and counted delicious eating.

In Skye appear many ruins of Daniſh forts, watch-towers, beacons, temples, and ſepulchral monuments. All the forts are known by the term *Dun;* ſuch as Dun-Skudborg, Dun-Derig, Dun-Skerineſs, Dun-David, &c.

SKY-Colour. To give this colour to glaſs, ſet in the furnace a pot of pure metal of fritt from rochetta or barilla, but the rochetta fritt does beſt; as ſoon as the metal is well purified, take for a pot of twenty pounds of metal ſix ounces of braſs calcined by itſelf; put it by degrees at two or three times into the metal, ſtirring and mixing it well every time, and diligently ſkimming the metal with a ladle: at the end of two hours the whole will be well mixed, and a proof may be taken; if the colour be found right, let the whole ſtand 24 hours longer in the furnace, and it will then be fit to work, and will prove of a moſt beautiful ſky colour.

SLAB, an outſide ſappy plank or board ſawed off from the ſides of a timber-tree. The word is alſo uſed for a flat piece of marble.

SLAB-Line, in ſea-language, a ſmall cord paſſing up behind a ſhip's main-ſail, or fore-ſail, and being reeved through a block attached to the lower part of the yard, is thence tranſmitted in two branches to the foot of the ſail, to which it is faſtened. It is uſed to truſs up the ſail as occaſion requires, and more particularly for the convenience of the pilot or ſteerſman, that they may look forward beneath it as the ſhip advances.

SLACK-WATER, in ſea-language, denotes the interval between the flux and reflux of the tide, or between the laſt of the ebb and the firſt of the flood, during which the current is interrupted, and the water apparently remains in a ſtate of reſt.

SLACKEN, in *Metallurgy*, a term uſed by miners to expreſs a ſpongy and ſemivitrified ſubſtance which is mixed with the ores of metals, to prevent their fuſion. It is the ſcoria or ſcum ſeparated from the ſurface of the former fuſions of metals. To this is frequently added limeſtone, and ſometimes a kind of coarſe iron-ore, in the running of the poorer gold ores.

SLATE, a ſtone of a compact texture and laminated ſtructure, ſplitting into fine plates, ſome varieties of which are employed for covering houſes. See *Clay-Slate*, under MINERALOGY, p. 185. See alſo GEOLOGY.

SLAVE. See SLAVERY.

SLAVERY is a word, of which though generally underſtood, it is not eaſy to give a proper definition. An excellent moral writer has defined it to be "an obligation to labour for the benefit of the maſter, without the contract or conſent of the ſervant." But may not he 1 Slavery defined.

Slavery. be properly called a ſlave who has given up his freedom to diſcharge a debt which he could not otherwiſe pay, or who has thrown it away at a game of hazard? In many nations, debts have been legally diſcharged in this manner; and in ſome ſavage tribes, ſuch is the univerſal ardour for gaming, that it is no uncommon thing for a man, after having loſt at play all his other property, to ſtake, on a ſingle throw of dice, himſelf, his wife, and his children (A). That perſons who have thus loſt their liberty are ſlaves, will hardly be denied; and ſurely the infatuated gameſter is a ſlave by his own contract. The debtor, too, if he was aware of the law, and contracted debts larger than he could reaſonably expect to be able to pay, may juſtly be conſidered as having come under an obligation to labour for the benefit of a maſter *with his own conſent*; for every man is anſwerable for all the known conſequences of his voluntary actions.

This definition of ſlavery ſeems to be defective as well as inaccurate. A man may be under an obligation to labour through life for the benefit of a maſter, and yet that maſter have no right to diſpoſe of him by ſale, or in any other way to make him the property of a third perſon; but the word *ſlave*, as uſed among us, always denotes a perſon who may be bought and ſold like a beaſt in the market (B). In its original ſenſe, indeed, it was of the ſame import with *noble*, *illuſtrious*; but vaſt numbers of the people among whom it had that ſignification being, in the decline of the Roman empire, ſold by their countrymen to the Venetians, and by them diſperſed over all Europe, the word *ſlave* came to denote a perſon in the loweſt ſtate of ſervitude, who was conſidered as the abſolute property of his maſter. See PHILOLOGY, N° 220.

2
Inequalities of rank inevitable. As nothing can be more evident than that all men have, by the law of nature, an equal right to life, liberty, and the produce of their own labour (ſee RIGHT, N° 5.), it is not eaſy to conceive what can have firſt led one part of them to imagine that they had a right to enſlave another. Inequalities of rank are indeed inevitable in civil ſociety; and from them reſults that ſervitude which is founded in contract, and is of temporary duration. (See MORAL PHILOSOPHY, N° 141.) He who has much property has many things to attend to, and muſt be diſpoſed to hire perſons to aſſiſt and ſerve him; while thoſe who have little or no property muſt be equally willing to be hired for that purpoſe. And if the maſter be kind, and the ſervant faithful, they will both be happier in this connection than they could have been out of it. But from a ſtate of ſervitude, where the ſlave is at the abſolute diſpoſal of his maſter in all things, and may be transferred without his own conſent from one proprietor to another, like an ox or an aſs, happineſs muſt be for ever baniſhed. How then came a traffic ſo unnatural and unjuſt as that of ſlaves to be originally introduced into the world? Slavery.

The common anſwer to this queſtion is, that it took its riſe among ſavages, who, in their frequent wars with each other, either maſſacred their captives in cold blood, or condemned them to perpetual ſlavery. In ſupport of this opinion we have heard it obſerved, that the Latin word *ſervus*, which ſignifies not a *hired* ſervant, but a *ſlave*, is derived from *ſervare*, "to preſerve;" and that ſuch men were called *ſervi*, becauſe they were captives, whoſe lives were preſerved on the condition of their becoming the property of the victor.

That ſlavery had its origin from war, we think extremely probable (C), nor are we inclined to controvert this etymology of the word *ſervus*; but the traffic in men prevailed almoſt univerſally long before the Latin language or Roman name was heard of; and there is no good evidence that it began among ſavages. The word עבד, in the Old Teſtament, which in our verſion is rendered *ſervant*, ſignifies literally a *ſlave*, either born in the family or bought with money, in contradiſtinction to שכיר, which denotes a hired ſervant: and as Noah makes uſe of the word עבד in the curſe which he denounces upon Ham and Canaan immediately after the deluge, it would appear that ſlavery had its origin before that event. If ſo, there can be little doubt but that it began among thoſe violent perſons whom our tranſlators have called *giants* *, though the original word נפלים literally ſignifies *aſſaulters of others*. Thoſe wretches ſeem firſt to have ſeized upon women, whom they forcibly compelled to miniſter to their pleaſures; and from this kind of violence the progreſs was natural to that by which they enſlaved their weaker brethren among the men, obliging them to labour for their benefit, without allowing them fee or reward.

3 Origin of ſlavery.

4 Prior to the deluge.

* Gen. vi. 4.

4 Nimrod enſlaved his captives.

After the deluge the firſt dealer in ſlaves ſeems to have been Nimrod. "He began," we are told, "to be a mighty one in the earth, and was a mighty hunter before the Lord." He could not, however, be the firſt hunter of wild beaſts; for that ſpecies of hunting muſt have been practiſed from the beginning; nor is it probable that his dexterity in the chaſe, which was then the univerſal employment, could have been ſo far ſuperior to that of all his contemporaries, as to entitle him to the appellation of the "the mighty hunter before the Lord." Hence moſt commentators have concluded, that he was a hunter of men; an opinion which they think receives ſome countenance from the import of his name, the word *Nimrod* ſignifying a rebel. Whatever be

(A) Aleam (quod mirere) ſobrii inter ſeria exercent, tanta lucrandi perdendive temeritate, ut cum omnia defecerunt, extremo ac noviſſimo jactu de libertate et corpore contendant. Victus voluntariam ſervitutem adit; quamvis junior, quamvis robuſtior, alligari ſe ac venire patitur.—*Tacitus de Mor. Germ.*

The ſavages of North America are equally addicted to gaming with the ancient Germans, and the negroes on the Slave Coaſt of Guinea perhaps ſtill more.

(B) The Roman orator's definition of *ſlavery*, Parad. V. is as accurate as any that we have ſeen. "Servitus eſt obedientia fracti animi et abjecti et arbitrio carentis ſuo;" whether the unhappy perſon fell into that ſtate with or without his own contract or conſent.

(C) In the article SOCIETY, the reader will find another account of the origin of ſlavery, which we think likewiſe probable, though we have not transferred it to this place; as it would, in our opinion, be wrong to give to one writer what we know to belong to another. It may be proper, however, to obſerve here, that between the two articles there is no contradiction, as barbarous wars were certainly *one* ſource of ſlavery.

Slavery.

be in this, there can be little doubt but that he became a mighty one by violence; for being the ſixth ſon of his father, and apparently much younger than the other five, it is not likely that his inheritance exceeded theirs either in extent or in population. He enlarged it, however, by conqueſt; for it appears from Scripture, that he invaded the territories of Aſhur the ſon of Shem, who had ſettled in Shinar; and obliging him to remove into Aſſyria, he ſeized upon Babylon, and made it the capital of the firſt kingdom in the world. As he had great projects in view, it ſeems to be in a high degree probable that he made bond-ſervants of the captives whom he took in his wars, and employed them in building or repairing the metropolis of his kingdom; and hence we think is to be dated the origin of poſtdiluvian ſlavery.

6
Slavery in the days of Abraham.

That it began thus early can hardly be queſtioned; for we know that it prevailed univerſally in the age of Abraham, who was born within ſeventy years after the death of Nimrod. That patriarch had three hundred and eighteen ſervants or ſlaves, born in his own houſe, and trained to arms, with whom he purſued and conquered the four kings who had taken captive his brother's ſon †. And it appears from the converſation which took place between him and the king of Sodom after the battle, that both believed the conqueror had a right to conſider his priſoners as part of his ſpoil. "Give me (ſays the king) the *perſons*, and take the *goods* to thyſelf." It is indeed evident from numberleſs paſſages of ſcripture, that the domeſtics whom our tranſlators call *ſervants* were in thoſe days univerſally conſidered as the moſt valuable part of their maſter's property, and claſſed with his flocks and herds. Thus when the ſacred hiſtorian deſcribes the wealth of Abraham, he ſays, that "he had ſheep and oxen, and he aſſes, and men-ſervants, and maid-ſervants, and ſhe-aſſes, and camels." And when Abimelech wiſhed to make ſome reparation to the patriarch for the unintended injury that he had done him, "he took ſheep and oxen, and men-ſervants, and women-ſervants, and gave them unto Abraham, and reſtored to him Sarah his wife." The riches and power of Iſaac and Jacob are eſtimated in the very ſame manner. Of the former it is ſaid, that "the man waxed great, and went forward and grew, until he became very great: for he had poſſeſſion of flocks, and poſſeſſion of herds, and great ſtore of ſervants, ועבדה of ſlaves; and the Philiſtines envied him." The latter, we are told, "increaſed exceedingly, and had much cattle, and maid-ſervants, and men-ſervants, and camels, and aſſes ‡."

† Gen. xiv.

‡ Gen. xii. 16. xx. 14. xxiv. 35. xxvi. 13, 14. xxx. 43.

That the practice of buying and ſelling ſervants thus early begun among the patriarchs deſcended to their poſterity, is known to every attentive reader of the Bible. It was expreſsly authoriſed by the Jewiſh law, in which are many directions how ſuch ſervants were to be treated. They were to be bought only of the heathen; for if an Iſraelite grew poor and ſold himſelf either to diſcharge a debt, or to procure the means of ſubſiſtence, he was to be treated not as a ſlave עבד, but as a hired ſervant שכיר, and reſtored to freedom at the year of Jubilee. "Both thy bond-men and thy bond maids (ſays Moſes) ſhall be of the heathen that are round about you: of them ſhall ye buy bond men and bond maids. And ye ſhall take them as an inheritance for your children after you, to inherit them for a poſſeſſion; they ſhall be your bond-men for ever ||." Unlimited as the power thus given to the Hebrews over their bond-ſervants of heathen extraction appears to have been, they were ſtrictly prohibited from acquiring ſuch property by any other means than fair purchaſe: "he that *ſtealeth* a man and ſelleth him," ſaid their great lawgiver, "ſhall ſurely be put to death §."

7
Authoriſed by the Mosaic law.

|| Lev. xxv. 39, 40, 44, 46.

§ Lev. xxi. 16.

Whilſt ſlavery, in a mild form, was permitted among the people of God, a much worſe kind of it prevailed among the heathen nations of antiquity. With other abominable cuſtoms, the traffic in men quickly ſpread from Chaldea into Egypt, Arabia, and over all the eaſt, and by degrees found its way into every known region under heaven (D).

8
Spread over the whole world.

Of this hateful commerce we ſhall not attempt to trace the progreſs through every age and country, but ſhall content ourſelves with taking a tranſient view of it among the Greeks and Romans, and a few other nations, in whoſe cuſtoms and manners our readers muſt be intereſted.

9
Slavery among the Greeks and

One can hardly read a book of the Iliad or Odyſſey, without perceiving that, in the age of Homer, all priſoners of war were liable to be treated as ſlaves, and compelled, without regard to their rank, ſex, or years, to labour for their maſters in offices of the vileſt drudgery. So univerſally was this cruel treatment of captives admitted to be the right of the victor, that the poet introduces Hector in the very act of taking a tender and perhaps laſt farewell of his wife, when it was ſurely his buſineſs to afford her every conſolation in his power, telling her, as a thing of courſe which could not be concealed, that, on the conqueſt of Troy, ſhe would be compelled

> To bear the victor's hard commands, or bring
> The weight of water from Hyperia's ſpring (E).
>
> POPE.

At that early period, the Phœnicians, and probably the Greeks themſelves, had ſuch an eſtabliſhed commerce in ſlaves, that, not ſatisfied with reducing to bondage their priſoners of war, they ſcrupled not to kidnap in cold blood

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(D) If credit be due to a late account of China, the people of that vaſt empire have never made merchandiſe of men or women. The exception, however, is ſo ſingular, that we ſhould be glad to ſee it better authenticated; for it is apparent from works of the moſt undoubted credit, that over all the other eaſtern countries with which we are acquainted ſlavery has prevailed from time immemorial, and that ſome of the Indian nations make long journeys into Africa for the ſole purpoſe of buying ſlaves.

(E) In thoſe early times drawing water was the office of the meaneſt ſlaves. This appears from Joſhua's curſe upon the Gibeonites who had deceived him —"Now therefore ye are curſed, and there ſhall none of you be freed from being bond-men, and hewers of wood, and drawers of water, for the houſe of my God." To this ſtate of bondage Homer makes Hector ſay, that Andromache would *neceſſarily* be brought upon the deſtruction of Troy; κρατερη δ' επικεισετ' αναγκη.—*Iliad.* lib. vi.

Slavery. blood persons who had never kindled their resentment, in order to supply their foreign markets. In the 14th book of the Odyssey, Ulysses represents himself as having narrowly escaped a snare of this kind laid for him by a false Phœnician, who had doomed the hero to Libyan slavery: and as the whole narrative, in which this circumstance is told, is an artful fiction, intended to have the appearance of truth to an Ithacan peasant, the practice of kidnapping slaves could not then have appeared incredible to any inhabitant of that island.

Such were the manners of the Greeks in the heroic age; nor were they much improved in this respect at periods of greater refinement. Philip of Macedon having conquered the Thebans, not only sold his captives, but even took money for permitting the dead to be buried *; and Alexander, who had more generosity than Philip, afterwards razed the city of Thebes, and sold the inhabitants, men, women, and children, for slaves †. This cruel treatment of a brave people may indeed be supposed to have proceeded, in the first instance, from the avarice of the conqueror; and in the second, from the momentary resentment of a man who was savage and generous by turns, and who had no command of his passions. We shall not positively assign it to other causes; but from the manner in which the Spartans behaved to their slaves, there is little reason to imagine that had they received from the Thebans the same provocation with Alexander, they would have treated their captives with greater lenity. "At Sparta (says a humane and elegant writer) slaves were treated with a degree of rigour that is hardly conceivable; although to them, as their husbandmen and artificers, their proud and idle masters were indebted for all the necessaries of life. The Lacedemonian youth, trained up in the practice of deceiving and butchering those poor men, were from time to time let loose upon them, in order to show their proficiency in stratagem and massacre. And once, without any provocation, and merely for their own amusement, we are told that they murdered three thousand in one night, not only with the connivance of law, but by its avowed permission. Such, in promoting the happiness of one part of society and the virtue of another, are the effects of slavery."

* *Justin.* lib. III. cap. 4.

† *Justin et Arrian*

Beattie's Moral Science, vol. II.

It has been said, that in Athens and Rome slaves were better treated than in Sparta: but in the former city their treatment cannot have been good, or their lives comfortable, when the Athenians relished that tragedy of Euripides in which Hecuba, the wife of Priam, is introduced as lamenting that she was chained like a dog at Agamemnon's gate? Of the estimation in which slaves were held in Rome, we may form a tolerable notion from the well-known fact, that one of those unhappy beings was often chained at the gate of a great man's house, to give admittance to the guests invited to a feast *. In the early periods of the commonwealth it was customary, in certain sacred shews exhibited on solemn occasions, to drag through the circus a slave, who had been scourged to death holding in his hand a fork in the form of a gibbet †. But we need not multiply proofs of the cruelty of the Romans to their slaves. If the inhuman combats of the gladiators (see GLADIATORS) admit of any apology on account of the martial spirit with which they were thought to inspire the spectators, the conduct of Vedius Pollio must have proceeded from the most wanton and brutal cruelty. This man, who flourished not in the earliest periods of the republic, when the Romans were little better than a savage banditti, but in the polished age of Augustus, frequently threw such slaves as gave him the slightest offence into his fishponds to fatten his lampreys; and yet he was suffered to die in peace! The emperor, indeed, upon coming to the knowledge of his cruelty, ordered his lampreys to be destroyed, and his ponds to be filled up; but we do not recollect that any other punishment was inflicted on the savage master. Till the reign of the same emperor the depositions of slaves were never admitted in the courts of judicature; and then they were received only when persons were accused of treasonable practices.

10 Romans.

* *Kames's Sketches.*

† *Cicero de Div.* lib. I. cap. 26.

11 Origin of Roman slavery.

The origin of slavery in Rome was the same as in every other country. Prisoners of war were of course reduced to that state, as if they had been criminals. The dictator Camillus, one of the most accomplished generals of the republic, sold his Hetrurian captives to pay the Roman ladies for the jewels which they had presented to Apollo. Fabius, whose cautious conduct saved his country when Hannibal was victorious in Italy, having subdued Tarentum, reduced 30,000 of the citizens to slavery, and sold them to the highest bidder. Coriolanus, when driven from Rome, and fighting for the Volsci, scrupled not to make slaves of his own countrymen; and Julius Cæsar, among whose faults wanton cruelty has never been reckoned, sold at one time fifty-three thousand captives for slaves. Nor did the slaves in Rome consist only of foreigners taken in war. By one of the laws of the twelve tables, creditors were empowered to seize their insolvent debtors, and keep them in their houses till, by their services or labour, they had discharged the sum they owed: and in the beginning of the commonwealth they were authorised to sell such debtors, and even to put them to death (F). The children of slaves were the property not of the commonwealth, or of their own parents, but of their masters; and thus was slavery perpetuated in the families of such unhappy

(F) After a certain number of citations, the law granted to the debtor thirty days of grace to raise the sum for which he was accountable. The words of the law are: "Æris confessi, rebusque jure judicatis, triginti dies justi sunto. Post dein manum endojacito.—Vincito aut nervo, aut compedibus." When the debt is confessed, and the trial passed, let there be thirty days of forbearance; afterwards lay hands on him; bind him either with a cord or fetters." After the thirty days were expired, if the debtor had not discharged the debt, he was led to the prætor, who delivered him over to the mercy of his creditors; these bound him and kept him in chains for the space of sixty days. Afterwards, for three market-days successively, the debtor was brought to the tribunal of the prætor; then a public crier proclaimed in the forum the debt for which the prisoner was detained. It often happened, that rich persons redeemed the prisoner by paying his debts; but if nobody appeared in behalf of the debtor after the third market-day, the creditor had a right to inflict the punishments appointed by the law. "Tertiis nundinis capite unhappy men as fell into that ſtate, whether through the chance of war or the cruelty of a ſordid creditor (G). The conſequence was, that the number of ſlaves belonging to the rich patricians was almoſt incredible. Caius Cæcilius Iſidorus, who died about ſeven years before the Chriſtian era, left to his heirs 4116 ſlaves; and if any one of thoſe wretched creatures made an unſucceſsful attempt to regain his liberty, or was even ſuſpected of ſuch a deſign, he was marked on the forehead with a red-hot iron (H). In Sicily, during the moſt flouriſhing periods of the commonwealth, it ſeems to have been cuſtomary for maſters to mark their ſlaves in this manner; at leaſt we know that ſuch was the practice of Damophilus, who, not ſatisfied with this ſecurity, ſhut up his ſlaves every night in cloſe priſons, and led them out like beaſts in the morning to their daily labour in the field. Hence aroſe the ſervile war in Sicily.

12
Its duration.

Though many laws were enacted by Auguſtus and other patriotic emperors to diminiſh the power of creditors over their inſolvent debtors; though the influence of the mild ſpirit of Chriſtianity tended much to meliorate the condition of ſlaves, even under Pagan maſters; and though the emperor Adrian made it capital to kill a ſlave without a juſt reaſon; yet this infamous commerce prevailed univerſally in the empire for many ages after the converſion of Conſtantine to the religion of Chriſt. It was not indeed completely aboliſhed even in the reign of Juſtinian; and in many countries which had once been provinces of the empire it continued long after the empire itſelf had fallen to pieces.

13
Slavery among the ancient Germans.

It has already been obſerved, that among the ancient Germans it was not uncommon for an ardent gameſter to loſe his perſonal liberty by a throw of the dice. This was indeed a ſtrong proof of ſavage manners; but the general condition of ſlaves among thoſe ſavages ſeems to have been much better than among the poliſhed Greeks and Romans. In Germany the ſlaves were generally attached to the ſoil, and only employed in tending cattle, and carrying on the buſineſs of agriculture; for the menial offices of every great man's houſe were performed by his wife and children. Such ſlaves were ſeldom beaten, or chained, or impriſoned. Sometimes indeed they were killed by their maſters in a fit of ſudden paſſion; but none were conſidered as materials of commerce, except thoſe who had originally been freemen, and loſt their freedom by play. Theſe, indeed, the ſucceſsful gameſter was very ready to ſell, both because he felt them an uſeleſs burden, and becauſe their preſence continually put him in mind of that ſtate to which a throw of the dice might one day reduce himſelf.

Such is the account which Tacitus gives * of ſlavery among the ancient Germans. The Anglo-Saxons, however, after they were ſettled in this iſland ſeem not to to have carried on that traffic ſo honourably. By a ſtatute of Alfred the Great †, the purchaſe of a *man*, a *horſe*, or an *ox*, without a voucher to warrant the ſale, was ſtrictly forbidden. That law was, doubtleſs, enacted to prevent the *ſtealing* of *men* and cattle; but it ſhows us that ſo late as the ninth or tenth century a man, when fairly purchaſed, was, in England, as much the property of the buyer as the horſe on which he rode, or the ox which dragged his plough. In the ſame country, now ſo nobly tenacious of freedom and the rights of man, a ſpecies of ſlavery ſimilar to that which prevailed among the ancient Germans ſubſiſted even to the end of the ſixteenth century. This appears from a commiſſion iſſued by Queen Elizabeth in 1574, for inquiring into the lands and goods of all her *bond-men* and *bond women* in the counties of Cornwall, Devon, Somerſet, and Gloucester, in order to compound with them for their manumiſſion, that they might enjoy their lands and goods as freemen ‡. In Scotland there certainly exiſted an order of ſlaves or bond-men, who tilled the ground, were attached to the ſoil, and with it were transferable from one proprietor to another, at a period ſo late as the thirteenth century; but when or how thoſe villains, as they were called, obtained their freedom, ſeems to be unknown to every lawyer and antiquary of the preſent day. Coalliers and ſalters were, in the ſame country, ſlaves till little more than 30 years ago, that they were manumitted by an act of the Britiſh legiſlature, and reſtored to the rights of freemen and citizens. Before that period the ſons of coalliers could follow no buſineſs but that of their fathers; nor were they at liberty to ſeek employment in any other mines than thoſe to which they were attached by birth, without the conſent of the lord of the manor, who, if he had no uſe for their ſervices himſelf, transferred them by a written deed to ſome neighbouring proprietor.

* De Mor. Germ. 24, 25.

† Wilkin's Collection of Laws from Ethelbert to Henry III.

14
In England and

‡ Kames's Sketches, book i. ſketch 5.

15
Scotland.

16
Slavery among the Carthaginians,

That the ſavage nations of Africa were at any period of

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capite pœnas dato aut trans Tiberim peregre venumduito;" that is, "Let him on the third market-day be puniſhed with death, or ſold beyond the Tiber as a ſlave." If there were ſeveral creditors, they were allowed, in conſequence of this ſevere law, to divide the body of the priſoner into ſeveral parts, and ſhare it among them in proportion to the ſum which they demanded.

(G) This is evident from the ſtory of Appius and Virginia. See ROME, N° 113.

(H) How capriciouſly and unjuſtly this infamous mark was impreſſed, we learn from the ſtory of Reſtio. This man being proſcribed, and a reward offered for his head by the triumvirs Octavianus, Antony, and Lepidus, concealed himſelf from the fury of the tyrants in the beſt way that he could. A ſlave whom he had marked with the hot iron having found out the place of his retreat, conducted him to a cave, and there ſupported him for ſome time with what he earned by his daily labour. At length a company of ſoldiers coming that way, and approaching the cave, the faithful ſlave, alarmed at the danger his maſter was in, followed them cloſe, and falling upon a poor peaſant, killed him in their preſence, and cut off his head, crying out, "I am now revenged on my maſter for the marks with which he has branded me." The ſoldiers, ſeeing the infamous marks on his forehead, and not doubting but he had killed Reſtio, ſnatched the head out of his hand, and returned with it in all haſte to the triumvirs. They were no ſooner gone, than the ſlave conveyed his maſter to the ſea-ſide, where they had the good luck to find one of Sextius Pompeius's veſſels, which tranſported them ſafe into Sicily.

Slavery.

of hiſtory exempted from this opprobrium of our nature which ſpread over all the reſt of the world, the enlightened reader will not ſuppoſe. It is indeed in that vaſt country that ſlavery has in every age appeared in its uglieſt form. We have already obſerved, that about the era of the Trojan war, a commerce in ſlaves was carried on between Phœnicia and Libya: and the Carthaginians, who were a colony of Phœnicians, and revered the cuſtoms, manners, and religion of their parent ſtate, undoubtedly continued the Tyrian traffic in human fleſh with the interior tribes of Africa. Of this we might reſt aſſured, although we had no other evidence of the fact than what reſults from the practice of human ſacrifices ſo prevalent in the republic of Carthage. The genuine inſtincts of nature are often ſubdued by dire ſuperſtition, but they cannot be wholly eradicated; and the rich Carthaginian, when a human victim was demanded from him to the gods, would be ready to ſupply the place of his own child by the ſon of a poor ſtranger, perfidiouſly purchaſed at whatever price. That this was, indeed, a very common practice among them, we learn from the teſtimony of various hiſtorians *, who aſſure us, that when Agathocles the tyrant of Syracuſe had overthrown their generals Hanno and Bomilcar, and threatened Carthage itſelf with a ſiege, the people attributed their misfortunes to the juſt anger of Saturn for having been worſhipped, for ſome years, by the ſacrifices of children meanly born and ſecretly *bought*, inſtead of thoſe of noble extraction. Theſe ſubſtitutions of one offering for another were conſidered as a profane deviation from the religion of their forefathers; and therefore to expiate the guilt of ſo horrid an impiety, a ſacrifice of 200 children of the firſt rank was on that occaſion made to the bloody god. As the Carthaginians were a commercial people, we cannot ſuppoſe that they purchaſed ſlaves only for ſacrifices. They undoubtedly condemned many of their priſoners of war to the ſtate of ſervitude, and either ſold them to foreigners, or diſtributed them among their ſenators and the leaders of their armies. Hanno, who endeavoured to uſurp the ſupreme power in Carthage whilſt that republic was engaged in war with Timoleon in Sicily †, armed 20,000 of his ſlaves in order to carry his nefarious purpoſe into execution; and Hannibal, after his deciſive victory at Cannæ, ſold to the Greeks many of his priſoners whom the Roman ſenate refuſed to redeem ‡. That illuſtrious commander was indeed more humane, as well as more politic, than the generality of his countrymen. Before his days it was cuſtomary with the Carthaginians either to maſſacre their captives in cold blood, that they might never again bear arms againſt them, or to offer them in ſacrifice as a grateful acknowledgement to the gods by whoſe aſſiſtance they believed that they were vanquiſhed; but this was not always done even by their moſt ſuperſtitious or moſt unprincipled leaders. Among other rich ſpoils which Agathocles, after his victory already mentioned, found in the camp of Hanno and Bomilcar, were twenty thouſand pair of fetters and manacles, which thoſe generals had provided for ſuch of the Sicilian priſoners as they intended to preſerve alive and reduce to a ſtate of ſlavery.

* *Polyb.* *Q. Curt.* *Diod. Sic.* See alſo *Ancient Univerſal Hiſtory*, vol. xv.

† *Juſtin.* lib. xxi. cap. 6. and *Univerſal Hiſtory.*

‡ *Tit. Liv.* *Appian* and *Zonaras.*

17
And Numidians.

With the ancient ſtate of the other African nations we are but very little acquainted. The Numidians, Mauritanians, Getulians, and Garamantes, are indeed mentioned by the Roman hiſtorians, who give us ample details of the battles which they fought in attempting to preſerve their national independence; but we have no particular account of their different manners and cuſtoms in that age when Rome was diſputing with Carthage the ſovereignty of the world. All the African ſtates of which we know any thing, were in alliance with one or other of thoſe rival republics; and as the people of thoſe ſtates appear to have been leſs enlightened than either the Romans or the Carthaginians, we cannot ſuppoſe that they had purer morals, or a greater regard for the ſacred rights of man, than the powerful nations by whom they were either protected or oppreſſed. They would, indeed, inſenſibly adopt their cuſtoms; and the ready market which Marius found for the priſoners taken in the town Capſa, although Salluſt acknowledges ‡ that the ſale was contrary to the laws of war, ſhows that ſlavery was then no ſtrange thing to the Numidians. It ſeems indeed to have prevailed through all Africa from the very firſt peopling of that unexplored country; and we doubt if in any age of the world the unhappy negro was abſolutely ſecure of his perſonal freedom, or even of not being ſold to a foreign trader.

‡ *Bell. Jug.* cap. 91.

18
Slave-trade with the coaſt of Guinea begun not by the Portugueſe,

It is the common opinion that the practice of making ſlaves of the negroes is of a very modern date; that it owes its origin to the incurſions of the Portugueſe on the weſtern coaſt of Africa; and that but for the cunning or cruelty of Europeans, it would not now exiſt, and would never have exiſted. But all this is a complication of miſtakes. A learned writer has lately proved, with a force of evidence which admits of no reply *, that from the coaſt of Guinea a great trade in ſlaves was carried on by the Arabs ſome hundreds of years before the Portugueſe embarked in that traffic, or had even ſeen a woolly-headed negro. Even the wandering Arabs of the deſert, who never had any friendly correſpondence with the Chriſtians of Europe, have from time immemorial been ſerved by negro ſlaves. "The Arab muſt be poor indeed (ſays M. Saugnier) not to have at leaſt one negro ſlave. His ſole occupation is the care of the herd. They are never employed in war, but they have it in their power to marry. Their wives, who are captive negreſſes, do all the domeſtic work, and are roughly treated by the Arabian women, and by the Arabs themſelves. Their children are ſlaves like them, and put to all kinds of drudgery." Surely no man whoſe judgement is not completely warped by prejudice, will pretend that thoſe roving tribes of ſavages, ſo remarkable for their independent ſpirit and attachment to ancient cuſtoms, learned to enſlave the negroes from the Europeans. In all probability they have, without interruption, continued the practice of ſlavery from the days of their great anceſtor Iſhmael; and it ſeems evident, that *none of the European nations had ever ſeen a woolly headed negro till the year* 1100, when the cruſaders fell in with a ſmall party of them near the town of Hebron in Judea, and were ſo ſtruck with the novelty of their appearance, that the army burſt into a general fit of laughter *. Long before the cruſades, however, we know with certainty that the natives of Guinea had been expoſed to ſale in foreign countries. In 651 the Mahometan Arabs of Egypt ſo haraſſed the king of Nubia or Ethiopia, who was a Chriſtian, that he agreed to ſend them annually, by way of tribute, a *vaſt number of Nubian or Ethiopian*

* *Whitaker's Review of Gibbon's Roman Hiſtory.*

19
But by the Arabs at an early period.

Saugnier and Briſſon's Voyages.

* *Malmſbury*, lcl. p. 83.

pian ſlaves into Egypt. Such a tribute as this at that time, we are told, was more agreeable to the khalif than any other, as the Arabs then made *no ſmall account of thoſe ſlaves* *.

* *Modern Univerſal Hiſtory*, vol. i. 525.

The very propoſal of ſuch a tribute, and the eſtimation in which black ſlaves were held in Egypt, ſhows that a commerce in bond-ſervants could not then be a new branch of trade either to the Arabs or the Ethiopians; but the vaſt number which the Ethiopian monarch was now compelled to furniſh every year, induced him to feed this great drain upon his ſubjects from the natives of the neighbouring countries. "He ranged accordingly into all that vaſt *blank of geography* upon the map of the world, the ſpreading boſom of the African continent; and even puſhed through it to its fartheſt extremities in the weſt. He thus brought the blacks of Guinea, for the firſt time, into the ſervice and families of the eaſt; and the ſlaves which he paid in tribute to the Arabs, whether derived from the nearer neighbourhood of Ethiopia, fetched from the mediterranean regions of Africa, or brought from the diſtant ſhores of the Atlantic, were all denominated *Ethiopians*, from the country by which they were conveyed into Egypt †. "At this time, therefore, according to Mr Whitaker, began that kind of traffic in human fleſh

† *Whitaker's Review.*

"Which ſpoils unhappy Guinea of its ſons."

There are not many authors from whom, in queſtions of antiquity, we differ with greater heſitation; but, as we meet with a female Ethiopian ſlave in the Eunuch of Terence, we cannot help ſuſpecting that Guinea was occaſionally "ſpoiled of its ſons" at a much earlier period. At any rate, from the obſervations made by the European travellers who firſt penetrated into that continent, it appears undeniable that ſlavery muſt have prevailed from time immemorial among ſuch of the tribes as had never carried on any commerce with foreign nations. When Battel firſt viſited the Giagas *, thoſe people had never before ſeen a white man; yet they welcomed him and the Engliſh, with whom he had come, to their country, invited them to bring their goods on ſhore, and without heſitation loaded the ſhips with ſlaves. The Giagas were indeed waging war with the kingdom of Benguela; and being cannibals, who prefer human fleſh to all others, the ſlaves whom they had ſold to the Engliſh were probably priſoners whom they would have killed and eaten if they had not found an opportunity of otherwiſe diſpoſing of them to greater advantage. But as they had not been incited by the Europeans to eat their priſoners, there can be no reaſon to ſuppoſe that by the Europeans they had been firſt induced to ſell them; for we have ſeen that this kind of commerce prevailed in Africa among people much more poliſhed than the Giagas ſo early as in the reign of Jugurtha.

20
The negroes have enſlaved one another from time immemorial.

* *Modern Univerſal Hiſtory*, vol. ... chap. 47. ſect. ...

That it was not introduced among the negroes either by the Arabs or by the Portugueſe, appears ſtill more evident from the behaviour of the Dahomans at the conqueſt of Whidah, and from the manner in which the people of Angola at the earlieſt ſtage of their foreign trade procured a ſupply of ſlaves for the Portugueſe market. The greater part of the ſlaves whom the Angolans exported from St Paulo de Loanda were brought from interior countries, ſome hundreds of leagues diſtant, where they could not have been regularly purchaſed had that commerce been till then unknown in thoſe countries. The Dahomans, in the beginning of the year 1727, had never ſeen a white man: and when their victorious prince and his army, in their rout through Whidah, firſt met with ſome Europeans in the town of Sabi, they were ſo ſhocked at their complexion and their dreſs, that they were afraid to approach them, and could not be perſuaded that they were men till they heard them ſpeak, and were aſſured by the Whidaneſe that theſe were the merchants who purchaſed all the ſlaves that were ſold in Guinea †. Slavery, therefore, if it prevailed among the Dahomans before that period, could not have been introduced among them by European or Arabian intrigues: but we are aſſured by Snelgrave, who was then in the army, that thoſe people treated their captives with ſuch horrid cruelty as was ſhocking to the natives of the ſea-coaſt, and leaves no room for doubt but that ſlavery had been practiſed among them from the earlieſt ages. A great part of their priſoners were ſacrificed to their gods or eaten by the ſoldiers; and when our author expreſſed to a colonel of the guard ſome ſurpriſe that a prince ſo enlightened as the ſovereign of Dahomy ſhould ſacrifice ſo many men whom he might have ſold to great advantage, he was gravely told, that it had been the cuſtom of their nation, from time immemorial, to offer, after victory, a certain number of priſoners to the gods; and that they ſelected the old men for victims, becauſe they were of leſs value at market, and more dangerous from their experience and cunning, than the young men. To thoſe perſons who fancy that the wars between the African princes are carried on for the ſole purpoſe of ſupplying the European ſhips with ſlaves, it may be proper to remark, that one of the kings of Dahomy ſlaughtered at once not only all the captives taken in war, but alſo 127 priſoners of different kinds, that he might have a ſufficiency of ſkulls to adorn the walls of his palace; though at the very time of that maſſacre he *knew* that there were ſix ſlave-ſhips in the road of Whidah, from which he could have got for every prime ſlave a price little ſhort of thirty pounds ſterling ‡.

† *Modern Univerſal Hiſtory*, vol. xiii.

Theſe facts, and numberleſs others which the reader will find detailed in the 13th volume of the Modern Univerſal Hiſtory, by writers who were at the greateſt pains to procure authentic information; who were neither biaſſed by intereſt nor blinded by enthuſiaſm; and who appear to have held the infamous traffic in utter abhorrence—prove beyond the poſſibility of doubt, that ſlavery of the worſt kind muſt have prevailed among all the negro nations before they were viſited either by the Portugueſe or by the Arabs (1). Theſe two nations may

‡ *Dalzel's Hiſtory of the Kingdom of Dahomy.*

(1) The ſame thing appears from the voyages of M. Saugnier, who had an opportunity of converſing with many tribes of negroes, and who always ſpeaks of ſlavery as an eſtabliſhed practice among them; adding, that ſuch as are ſold for crimes are put to death by their own countrymen if they fly from their maſter. It appears likewiſe in a ſtill more ſtriking light from Dalzel's Hiſtory of Dahomy, where we are told that all the Dahomans,

Slavery.

may indeed have been the firſt who dragged the unhappy negro from his native continent, and made his ſlavery doubly ſevere, by compelling him to labour, without his own conſent, for maſters whom he hardly conſidered as human beings.

On the beginning of this commerce, or the dreadful cruelty with which it has been carried on to the preſent day, it is impoſſible to reflect without horror: but there is ſome conſolation, however ſmall, in knowing that its original authors were not Europeans. The purchaſe of Guinea blacks for ſlaves by foreign nations commenced ages before the Portugueſe had laid that country open to the intercourſe of Europe. Even after they had made many incurſions into it, the inhabitants were as regularly purchaſed for ſlaves by ſome of the adjoining ſtates as they are now by the maritime Europeans.

21 The route by which the Arabs carried on the ſlave-trade. *Whitaker's Review*, p. 185.

"The Arabs of Egypt having reduced all the north of Africa, and carrying with them their love of black ſervants, would be ſure to open a ready communication for themſelves to their country. They certainly had one ſo early as 1512, and before the Europeans had any for that purpoſe (K). They went from Barbary by a route that was ſo much practiſed, as to be denominated expreſly 'the way of the camels.' Meeting together at the town of Cape Cantin, or that of Valadie near it, the commercial caravan traverſed the vaſt deſerts, thoſe of Sarra, which run like the tropic of Cancer over them in a long line acroſs the country; to a place of great population called Hoden, the *Waden* or *Hoden* of our maps, and a little to the ſouth-weſt of Cape Blanco. From Hoden they turned to the left, and puſhed directly into the interior of the continent, to reach Tegazza, the *Tagazel* or *Tagaza* of our maps, and lying nearly eaſt of Hoden. Here aſſuredly they did, as the caravan does certainly at this day; and added to the other wares upon their camels a quantity of ſalt from thoſe mines of rock-ſalt, which are extraordinary enough to be noticed as rocks in our maps. This they carried, as they ſtill carry it, to Tanbut, the *Tombut* of the maps, and a town in the heart of the African continent. And from this town they turned on the right for the ſea coaſt again, and reached it in the great kingdom of Mele, the *Melli* of our maps, to the ſouth of the Gambia, and juſt at the ſpringing as it were of that grand arch of ſea which curves ſo deeply into the body of the land, and conſtitutes the extenſive gulf of Guinea. At Melli and at Tombut they received a meaſure of gold for a meaſure of ſalt. The caravan collects gold at Tombut to the preſent time; but at Melli they purchaſed gold, and alſo ſilver, in pieces as large as pebbles. And at Hoden they had *a great mart for ſlaves*; the blacks being brought thither from the countries adjoining, and bartered away to the traders. Such was the Slave Coaſt and the Gold Coaſt of former days. The ſtaple commodity of Hoden is only transferred now to Whidah; and diverted from the Arabs of Barbary to the Chriſtians of Europe," by whom the negroes are carried to the continent of America or to the Sugar Iſlands in the Weſt Indies. In theſe countries they are all ſold like beaſts in a market; but they experience very different degrees of ſervitude from the different maſters who hold them as property. Such of them as are reconciled to the appearance of white men, or have been born in the European colonies, feel themſelves as happy under a humane maſter as they could be in their native continent (L); and we believe that few of them in ſuch circumſtances have expreſſed a deſire to return."

22 which is now transferred to the Europeans.

23 Condition of ſlaves in the French Weſt Indies under the old government.

In the French Weſt India iſlands, before the late revolution in the mother country, which has produced in all its dependencies anarchy and maſſacre, the condition of the negro ſlaves was better than that of the bondmen among the ancient Germans. "Thoſe of them who cultivated the plantations were attached to the ſoil, and could not be drawn off to pay debts, or be ſold ſeparately from the eſtate on which they lived. This gave them a laſting property in their huts and little ſpots of ground, which they might ſafely cultivate without dread of being turned out of poſſeſſion, or transferred contrary to their intereſt and feelings from one proprietor to another. They were under the protection of law as ſoon as they arrived in the colony. Proper miſſionaries were appointed for the purpoſe of training them up to a certain degree of religious knowledge, and ample funds were allotted for the maintenance of thoſe eccleſiaſtics. On ill treatment received from his maſter, or on being deprived of his allowance of food and raiment, the ſlave was directed to apply to the king's attorney,

mans, from the loweſt to the higheſt, acknowledge the right of the ſovereign to diſpoſe of their perſons and properties at pleaſure; and where we learn, that the ſovereign himſelf aſſured Mr Abſon the Engliſh governor at Whidah, that all his anceſtors had from time immemorial put to death every priſoner of war whom they could not ſell as a ſlave.

(K) In the year 1442, Anthony Gonſalez, a Portugueſe adventurer, reſtored to their native country ſome Mooriſh priſoners whom he had two years before forcibly carried off from the coaſt of Africa. He landed them at *Rio del-Oro*, and received from the Moors in exchange ten blacks and a quantity of gold duſt. This tranſaction proves, that a commerce in black ſervants was then regularly carried on by the Moors and not by the Portugueſe. So early as the year 1502, the Spaniards began to employ a few negroes in the mines of Hiſpaniola; but in the year following, Ovando, the governor of that iſland, forbade the further importation of them, alleging that they taught the Indians all manner of wickedneſs, and rendered them leſs tractable than formerly: and it was not till the year 1517 that the ſupply of negroes to the Spaniſh American plantations became an eſtabliſhed and regular branch of commerce. *Edwards's History of the Weſt Indies*, Book IV. chap. ii.

(L) "I have obſerved many of my ſlaves go on board the veſſel with joy, on my aſſurance that they would be well treated and happy on the plantation where I was going to ſend them. When the Banbarans find that they are truſted by the whites, they never think of making their eſcape, chooſing to be the ſlaves of *Europeans* rather than of a *black man* who would treat them with the greateſt cruelty. *Voyages to the Coaſt of Africa by Meſſrs Saugnier and Briſſon*, p. 332. 335. Engliſh Tranſlation.

Slavery. torney, who was obliged to prosecute the master forthwith. That officer was also bound to prosecute, if by any other means he heard of the abuse; the law adding as the reason, *This we will to be observed, to check the abuse of power in the master* *."

* Ramsay's Essay on the Treatment and Conversion of Slaves, Sect. v.

24
In the British islands.

We wish it were in our power to say, that in the British West India colonies slaves are equally protected by law as they were in the French islands under the old government, and that the same care is taken of their moral and religious improvement. This, however, we are afraid, cannot be said with truth. In the island of Jamaica, before the passing of the *consolidated slave act*, not many years ago, a white man, whether proprietor or not, who had killed a negro, or by an act of severity been the cause of his death, was, for the first offence, intitled to benefit of clergy, and not liable to capital punishment till a repetition of the crime. By the present law, it is enacted, "That if any person, whether owner or superintendant of slaves, shall be convicted of having, by any act of passion or cruelty, occasioned the death of any negro, it shall be capital for the *first* offence: and for the greater security of the property, and as a check on those who may have the punishment of slaves in their power, it is particularly required, that every surgeon or doctor belonging to each estate shall swear to the cause of the death of each negro, to the best of his knowledge and belief; and if any negro dies, and is interred by the owner or overseer, without the doctor's having seen or been sent for to such negro, in this case the owner or overseer causing the negro to be so interred is liable to a prosecution for such conduct."

M'Neil's Observations on the Treatment of Negroes in the island of Jamaica.

This law must doubtless be productive of good effects, but being a colonial act, it cannot have the vigour of the *Code Noir;* nor do we know of any attorney in the island who is *obliged* to defend the rights of the negroes, or prosecute the master whose cruelty has by any means come to his knowledge. The justices and vestry of each parish are indeed constituted *a council of protection*, for the express purpose of making full enquiry into the barbarities exercised on slaves, and bringing the authors to punishment at the public expence; and by a new slave-act of Grenada, the justices are required annually to nominate three freeholders to be *guardians of the slaves*, who are to take an oath to see the law duly executed †. These are benevolent regulations; but we doubt if protection can be so promptly afforded by a council of guardians as by an individual attorney who has no other employment. In some of the other British islands, we have been confidently told that the unfortunate sons of Africa have no protection whatever against the tyranny of a sordid owner, or the caprice of a boyish overseer (M); though it is added, that the humanity of many masters more than supplies the want of laws in every respect but that of improvement, and that the attachment of others has in them a like effect. In some cases good sense, a regard for their reputation, and a well-informed conviction of their interest, induce men to treat their slaves with discretion and humanity. The slaves of many a planter possess advantages beyond what the labourer even of Britain enjoys ‡;" yet these advantages all depend upon the good will of his master; and in no part of the British colonies are the slaves attached to the soil. This single circumstance, together with the total neglect of their moral and religious culture, makes their situation much less eligible than was that of the French slaves under the old government; and affords a striking proof of what the humane author whom we have just quoted well observes, that "those men and nations whom liberty hath exalted, and who therefore ought to regard it tenderly in others, are constantly for restraining its blessings within their own little circle, and delight more in augmenting the train of their dependants than in adding to the rank of fellow-citizens, or in diffusing the benefits of freedom among their neighbours."

† Edwards's Hist. of the West Indes, book iv. chap. v.

‡ Ramsay's Essays, p. 66. and 91.

25
The lawfulness of slavery inquired into.

Having given this ample detail of the rise and progress of slavery in the world, and shown that it has prevailed in every age, and under all religions, we shall now proceed to enquire whether a practice so general be in any instance lawful; and if it be, how it must be modified, in order to be rendered consistent with the rights of man and the immutable laws of virtue.

That in a state of nature one man has a right to seize upon another, and to compel him by force to labour for his subsistence, is a position which we believe has never been seriously maintained. But independent communities stand to each other in the very same relation that individuals do in a state of nature; and therefore if in such a state the man of greater bodily strength or mental sagacity would have no right to convert his weaker neighbour into personal property, neither can the more powerful and enlightened nation have a right to carry off by force, or entice by fraud, the subjects of a weaker and more barbarous community for the purpose of reducing them to a state of servitude. This is a truth so obvious as to admit neither of proof nor of denial.

In thus stating the case between two independent nations, we have in our eye that traffic in slaves which is carried on between the civilized Europeans and the barbarous Africans: and the utmost length which we think an apologist for that trade can go is to contend, that we may lawfully purchase slaves in those countries where from time immemorial they have been a common branch of commerce. But the European right to purchase cannot be better than the African right to sell; and we have never yet been informed what gives one African a right to sell another. Such a right cannot be natural, for the reason which we have elsewhere assigned (see RIGHT): neither can it be adventitious; for adventitious rights are immediately derived from the municipal law, which is the public will of the state. But the state has no authority to deprive an innocent man of his personal freedom, or of the produce of his own labour; for it is only to secure these, by protecting the weak

26
The common apology for it insufficient.

(M) In Barbadoes there is said to be a law for the protection of slaves, which is the most insolent trifling with justice and humanity that the writer of this article has ever seen. It is enacted, forsooth, "That if any man shall, of *wantonness*, or only of *bloody-mindedness*, or *cruel intention*, *wilfully kill* a negro or other slave, if his own, he shall pay into the public treasury *fifteen pounds sterling!* See *Dickson's Letters on Slavery*, p. 4.

weak from the violence of the strong, that states are formed, and individuals united under civil government.

It may perhaps be said, that by patiently submitting to governments which authorize the traffic in human flesh, men virtually give up their personal liberty, and vest their governors with a right to sell them as slaves: but no man can vest another with a right which he possesses not himself; and we shall not hesitate to affirm, that in a state of nature where all have equal rights, no individual can submit himself to the absolute disposal of another without being guilty of the greatest crime. The reason is obvious. From the relation in which men stand to one another as fellow-creatures, and to God as their common Creator, there are duties incumbent upon each peculiar to himself; in the performance of which he can be guided only by his own reason, which was given him for that very purpose. But he who renounces his personal freedom, and submits unconditionally to the caprice of a master, impiously attempts to set himself free from the obligation of that law which is interwoven with his very being, and chooses a director of his conduct different from that which God has assigned him. A man therefore cannot put himself in a state of unconditional servitude; and what he cannot do for himself, he surely cannot authorize others to do for him either by a tacit or by an open consent.

27
No man has a right to give himself up to the absolute disposal of another.

These considerations have often made us regret that writers, for whose talents and integrity we have the highest respect, should, without accurately defining what they mean by slavery, have peremptorily affirmed, that, consistently with the law of nature men may be reduced to that state as a punishment for crimes, or to discharge debts which they cannot otherwise pay. That a criminal, who has forfeited his life to the laws of his country, may have his punishment commuted for hard labour, till death in the course of nature shall put a period to his terrestrial existence, is a truth which we apprehend cannot be controverted; but to make such a commutation of punishments consistent with the laws of nature and of nature's God, it appears to us that the kind and degree of labour must be precisely ascertained, and the conduct of the criminal not left to the capricious direction of any individual.

28
What kind of slavery may be employed as a punishment.

Punishments can be justly inflicted only for one or other of two ends, or for both. They may be calculated either to reform the criminal or to be a warning to the innocent; and those which most effectually answer both these purposes are surely to be preferred to such as answer but one of them. For this reason we consider hard labour as a much fitter punishment for most crimes than death: but to entitle it to preference, the kind and degree of the labour must be ascertained by the law; for if these circumstances be omitted, and the offender delivered over as a slave to the absolute disposal and caprice of a private master, the labour to which he is condemned, instead of operating to his reformation, may be converted into the means of tempting him to the commission of new crimes. A young woman, in the state of servitude, would hardly be able to maintain her virtue against the solicitations of a master who should promise her liberty or a remission of toil upon her yielding to his desires; and the felon, who had long been accustomed to a life of vagrancy and idleness, would not strenuously object to the perpetration of any wickedness to obtain his freedom, or even a diminution of his daily task. Indeed such temptations might be thrown in his way, as human nature could not resist but by means of much better principles than felons can be supposed to possess. He might be scourged into compliance; or his labour might be so increased as to make him for a little respite eagerly embrace the most nefarious proposal which his master could make: for being absolute property, there is no earthly tribunal to which he could appeal for justice; and felons do not commonly support themselves under trials by pious meditations on a future state.

By reasoning in this way, we are far from meaning to insinuate that slave-holders in general torture their slaves into the commission of crimes. God forbid! Many of them we know to be religious, humane, and benevolent: but they are not infallible; and some of them may be instigated, some of them undoubtedly have been instigated, by avarice and other worse principles, to compel creatures, who are so absolutely their dependents, to execute deeds of darkness too hazardous for themselves. But the morality or immorality of any action, and the moral fitness of any state, are to be judged of by their natural tendency, if the one were universally practised and the other universally prevalent (see Moral Philosophy, N° 156.): and as the natural tendency of absolute domestic slavery among such creatures as men is to throw the most powerful temptations to vice in the way both of master and of slave, it must be in every instance, even when employed as a punishment, inconsistent with the fundamental principles of moral virtue.

Some writers indeed have maintained, and the civil law seems to suppose, that children are the property of their parents, and may by them be sold as slaves in cases of urgent necessity: but if we duly consider how property is acquired (see Property), and attend to the natural consequences of slavery, we shall soon be convinced that this opinion is very ill founded. The rights of parents result from their duties; and it is certainly the duty of that man who has been the instrument of bringing into the world an intellectual and moral being, to do every thing in his power to render the existence of that being happy both in the present life and in that which is to come. If this duty be conscientiously discharged, the parent has a manifest right to the gratitude, love, and reasonable obedience, of his child; but he cannot, in consequence of any duty performed, claim a right to transfer that child as property to the uncontrolled disposal of any private master; for this plain reason, that the man who is considered as the private property of another, cannot reasonably be supposed to enjoy happiness in this world, and is under many temptations to do what must necessarily render him miserable in the next. See Moral Philosophy, N° 138.

29
Children not the property of their parents.

If criminals cannot be lawfully reduced to a state of absolute private slavery, much less surely can it be lawful to reduce insolvent debtors and prisoners of war to that state. Many a virtuous man, who has contracted debts with the fairest prospect of paying them, has been suddenly rendered insolvent by fire, by shipwreck, or by the bankruptcy of others with whom he was necessarily engaged in the course of his trade. Such a man can be considered in no respect as criminal. He has been indeed unfortunate; but it would be grossly unjust, as well

well as ſhockingly cruel, to add to his misfortune by reducing him to a ſtate to which we have juſt ſeen that the vileſt felon cannot be reduced without a violation of the laws of morality. Fraudulent bankrupts indeed, of whom we daily ſee many, might with great propriety and the ſtricteſt juſtice be compelled to extenuate their debts by labouring for the benefit of thoſe whom they have injured; and criminals of other deſcriptions might be made to work for the benefit of the public: but in both caſes the taſk to be performed ſhould be aſcertained by the law, and the perſons of the labourers be protected by the ſtate. If ſuch can be called ſlaves, their ſlavery is undoubtedly conſiſtent with every principle of virtue and religion; for they ſuffer nothing but the due reward of their deeds. Priſoners of war, however, can upon no honeſt principle be reduced even to this ſtate of mitigated bondage; for they are ſo far from incurring guilt by fighting for their country, that even to their enemies their courage and conduct in ſuch a cauſe muſt appear worthy of reward. A victorious general has certainly a right to prevent the priſoners taken in battle from again drawing their ſwords againſt him during the continuance of the war; but there are many ways by which this may be done effectually without chaining the unfortunate captives to the oar, or ſelling them like cattle to private purchaſers, by whom they may be treated with capricious cruelty, and driven to the perpetration of the greateſt crimes.

30
Fraudulent bankrupts may be compelled to labour for the benefit of their creditors.

31
Two objections to our concluſions.

To theſe concluſions, and the reaſoning on which they are built, we are aware it may be objected, that if private ſlavery were in every inſtance unlawful and inconſiſtent with the fundamental principles of morality, it would not have prevailed among the ancient patriarchs, and far leſs have been authoriſed by the Jewiſh law.

32
The former anſwered.

In reply to this objection, it may be obſerved, that Abraham, Iſaac, and Jacob, though excellent men, were not characters abſolutely perfect; that as their practice does not authoriſe polygamy or inceſt among us, it will not authoriſe the reducing of our fellow-creatures to a ſtate of hopeleſs ſervitude; and that from the circumſtances of the age in which they lived, many things were permitted to them, and were indeed harmleſs, which are forbidden to us, and would now be pernicious. The character of Abraham appears to have been much more perfect than that of his ſon or grandſon; and was certainly equal, if not ſuperior, to that of any other mere man of whom we read either in profane or even in ſacred hiſtory. We are to remember, however, that he was born amidſt idolaters, and was probably an idolater himſelf till enlightened by the inſpiration of Jehovah, and called from his kindred and from his father's houſe. Before his converſion, he muſt have had much cattle and many ſlaves, which conſtituted the riches of that early period; and his caſe would indeed have been peculiarly hard, had he been commanded to diveſt himſelf of his ſervants, and to depart into a ſtrange country very thinly inhabited, without people to protect his flocks and herds from beaſts of prey. Nor would his loſs have contributed in any degree to the benefit of his ſlaves, who, as the ranks of men were then adjuſted, could not long have preſerved their liberty. Had they not been forcibly reduced to their former ſtate by their idolatrous countrymen, which in all probability they would have been, they muſt have ſoon ſubmitted to it, or periſhed by hunger. Let it be remembered, too, that the bond-ſervants of Abraham, though conſtituting the moſt valuable part of his property, were not conſidered as a ſpecies of inferior beings, but were treated rather as children than as ſlaves. This is evident from his ſpeaking of the ſteward of his houſe as his heir, when complaining to God of the want of ſeed. Indeed the manner in which this circumſtance is mentioned, ſhows that it was then the general practice to conſider domeſtic ſlaves as members of the family; for the patriarch does not ſay, "I will leave my ſubſtance to this Eliezer of Damaſcus;" but his words are, "Behold to me thou haſt given no ſeed; and lo, one born in my houſe is *my heir* *." From this mode of expreſſion we are ſtrongly inclined to think that captives taken in war were in that age of ſimplicity incorporated into the family or tribe of the conqueror, as they are ſaid to be at preſent among the North American Indians, to ſupply the place of thoſe who had fallen in battle. If ſo, ſlavery was then a very mild thing, unattended with the evils which are now in its train, and muſt often have been highly beneficial to the captive.

* Gen. xv. 3.

33
Anſwer to the other.

The other part of the objection appears at firſt ſight more formidable: but perhaps a little attention to the deſign of the Moſaic economy may enable us to remove it even more completely than this. We need not inform our theological readers, that one great purpoſe for which the poſterity of Abraham were ſeparated from the heathen nations around them, was to preſerve the knowledge of the true God in a world run headlong into idolatry. As idolatry appears to have had ſomething in its forms of worſhip extremely captivating to rude minds, and as the minds of the Iſraelites at the era of their departure from Egypt were exceedingly rude, every method was taken to keep their ſeparation from their idolatrous neighbours as complete as poſſible. With this view they were commanded to ſacrifice the animals which their Egyptian maſters had worſhipped as gods, and were taught to conſider hogs and ſuch other creatures as the heathen offered in ſacrifice, when celebrating their myſtical and magic rites, as too unclean to be eaten or even to be touched. Of this diſtinction between clean and unclean beaſts, God himſelf aſſigns the reaſon: "I am the Lord your God (ſays he), who have ſeparated you from other people; ye ſhall therefore put difference between clean and unclean beaſts, and between unclean fowls and clean †." For the ſame reaſon they were prohibited from intermarrying with the heathen, or having any tranſaction whatever with them as neighbours; and the ſeven idolatrous nations of Canaan they were ſtrictly commanded to exterminate. "When the Lord thy God (ſays Moſes) ſhall deliver them before thee, thou ſhalt ſmite them, and utterly deſtroy them: thou ſhalt make no covenant with them, nor ſhow mercy unto them: neither ſhalt thou make marriages with them: thy daughter thou ſhalt not give unto his ſon, nor his daughter ſhalt thou take to thy ſon; for they will turn away thy ſon from following me, that they may ſerve other gods ‡."

† Lev. xx. 24, 25, 26.

‡ Deut. vii. 2, 3, 4.

Under theſe laws, it is plain that no intercourſe whatever could have place between an Iſraelite and a man of any other nation, unleſs the latter was reduced to ſuch a ſtate as that he could neither tempt the former, nor practiſe himſelf the rites of his idolatrous worſhip.

Slavery, Slave-trade.

But the Iſraelites were not ſeparated from the reſt of the world for their own ſakes only: They were intended to be the repoſitaries of the lively oracles of God, and gradually ſpread the light of divine truth through other nations, till the fulneſs of time ſhould come, when in Chriſt all things were to be gathered together in one. To anſwer this end, it was neceſſary that there ſhould be ſome intercourſe between them and their Gentile neighbours; but we have ſeen that ſuch an intercourſe could only be that which ſubſiſts between maſters and their ſlaves.

Should this apology for the ſlavery which was authoriſed by the Jewiſh law be deemed fanciful, we beg leave to ſubmit to the conſideration of our readers the following account of that matter, to which the ſame objection will hardly be made. It was morally impoſſible that between nations differing ſo widely in religion, cuſtoms, and manners, as the Jews and Gentiles, peace ſhould for ever reign without interruption; but when wars broke out, battles would be fought, and priſoners would be taken. How were theſe priſoners to be diſpoſed of? Cartels for exchange were not then known: it was the duty of the Iſraelites to prevent their captives from taking up arms a ſecond time againſt them; they could not eſtabliſh them among themſelves either as artificers or as huſbandmen; for their law enjoined them to have no communication with the heathen. There was therefore no other alternative but either to maſſacre them in cold blood, or to reduce them to the condition of ſlaves. It would appear, however, that thoſe ſlaves were raiſed to the rank of citizens, or at leaſt that their burdens were much lightened, as ſoon as they were convinced of the truth of the Moſaic revelation, and received into covenant with God by the rite of circumciſion. They were then admitted to the celebration of the paſſover; concerning which one law was decreed to the ſtranger, and to him that was home-born. Indeed, when we conſider who was the legiſlator of the Jews; when we reflect upon the number of laws enacted to mitigate ſlavery among them, and call to mind the means by which the due execution of all their laws was enforced, (ſee THEOLOGY), we cannot help being of opinion that the heathen, who was reduced to ſlavery in Judea, might be happier, if he pleaſed, than when living as a freeman in his own country. But whether this be ſo or not, is a matter with which we have no concern. On account of the hardneſs of their hearts, and the peculiarity of their circumſtances, many things, of which ſlavery may have been one, were permitted to the Jews, which, if practiſed by Chriſtians, would render them highly guilty.

After treating thus largely of ſlavery in general, we need not occupy much of the reader's time with the

34 Slave-trade.

SLAVE-TRADE carried on by the merchants of Europe with the natives of Africa. It is well known that the Portugueſe were the firſt Europeans who embarked in this trade, and that their example was ſoon followed by the Dutch and the Engliſh. Of the riſe and progreſs of the Engliſh commerce in ſlaves, the reader will find a ſufficient account in other articles of this work †. That commerce, though long cheriſhed by the government as a ſource of national and colonial wealth, was from its commencement conſidered by the thinking part of the nation as a traffic inconſiſtent with the rights of man, and ſuſpected to be carried on by acts of violence. Theſe ſuſpicions were gradually ſpread through the people at large, and confirmed, in many inſtances, by evidence incontrovertible. Laws were in conſequence enacted to make the negroes more comfortable on what is called the middle paſſage, and to protect them againſt the wanton cruelty of their maſters in the Weſt Indies: but the humanity of the nation was rouſed; and not many years ago a number of gentlemen of the moſt reſpectable characters, finding that no adequate protection could be afforded to perſons in a ſtate of hopeleſs ſervitude, formed themſelves into a ſociety at London, for the purpoſe of procuring a total abolition of the ſlave-trade. That the motives which influenced the leading men of this ſociety were of the pureſt kind, cannot, we think, be queſtioned; for their object was to deliver thoſe who had none to help them, and from whom they could expect no other reward for their labours of love than the bleſſings of them who were ready to periſh. To a cauſe truly Chriſtian, who did not pray for ſucceſs? or who but muſt have felt the moſt pungent regret, if that ſucceſs had been rendered doubtful, or even delayed, by the imprudence of ſome of the agents employed by the ſociety? This we apprehend was really the caſe. Language calculated only to exaſperate the planters could not ſerve the negroes; and the legiſlature of Great Britain would never ſuffer itſelf to be forced into any meaſure by the menaces of individuals.

† See *Company*, and *Guinea*.

35 Petitions for the abolition of it.

In the year 1793, petitions were preſented to parliament for the abolition of this inhuman traffic, which gave a pleaſing picture of the philanthropy of the nation; but, unfortunately for the cauſe of freedom, it was diſcovered that many of the names ſubjoined to thoſe petitions had been collected by means not the moſt honourable. The diſcovery, perhaps, would never have been made, had not the inſulting epithets indiſcriminately heaped upon the ſlave-holders provoked thoſe men to watch with circumſpection over the conduct of their opponents. The conſequence was, that ſuſpicions of unfair dealing on the part of the petitioners were excited in the breaſts of many who, though they ardently wiſhed well to the cauſe, choſe not to add their names to thoſe of ſchool-boys under age, and of peaſants who knew not what they were ſubſcribing. Let the rights of the Africans be maintained with ardour and firmneſs; but never let their advocates ſuppoſe that the cauſe of humanity requires the ſupport of artifice. Abſolute ſlavery, in which the actions of one man are regulated by the caprice of another, is a ſtate demonſtrably inconſiſtent with the obvious plan of the moral government of the world. It degrades the mental faculties of the ſlave, and throws, both in his way and in his maſter's, temptations to vice almoſt inſurmountable. Let theſe truths be ſet in a proper light by thoſe who have doubtleſs ſeen them exemplified; and they will ſurely have their full effect on the minds of a generous, and, we truſt, not an impious people (N). The trade will be generally aboliſhed; pains will be taken

(N) We have not inſiſted upon the impolicy of the ſlave-trade, or endeavoured to prove that its abolition would

Slave-trade.

ken to cultivate the minds of the West Indian negroes; and the era may be at no great distance when slavery shall cease through all the British dominions.

36 Objection to the abolition

But what benefit, it will be asked, will the negroes of Africa reap from an abolition of the slave trade? Should any thing so wildly incredible happen, as that all the nations of Christendom, in one common paroxysm of philanthropy, should abandon this commerce in servants, which has been prosecuted in all ages, and under all religions; they would only abandon it to those who were originally possessed of it, who still penetrate into the country, and who even push up to Gago at the very head of the Slave coast; and leave the wool-headed natives of it to Mahometan masters, in preference to Christian. Under such masters they were in Judea at the time of the crusades. Under such, as we learn from Messrs Saugnier, Brisson, and others, they still are in the deserts of Africa, as well as in the islands of Johanna and Madagascar *; and it is universally known that they enslave one another as a punishment for the most whimsical crimes. Among them, indeed, slavery seems to be reduced to a system, and to descend, as it has done in more polished nations, from father to son; for both Saugnier and Wadstrom † speak of particular families of negroes who are exempted from that degrading state by the laws of the country.

* *Asiatic Researches*, vol. ii.

† *Essay on Colonization.*

All this we admit to be true. Most certainly the negroes would not be exempted from the miseries of servitude, though Europe and the West Indies were swallowed up in the ocean. The *customs* of the country, as the king of Dahomy assured Mr Abson ‡, will be *made* as long as black men shall continue to possess their own territories, in their present state of depravity and ignorance; and these customs appear to involve slavery of the cruellest kind. But if slavery be in itself unlawful, is it a sufficient excuse for our continuing the traffic that it is carried on by the rude negroes and the savage Arabs? Are people, whom we sometimes affect to consider as an inferior order of beings, to furnish examples of conduct to those who boast of their advancements in science, in literature, and in refinement? Or will the benevolent Lord of all things pardon us for oppressing our helpless brethren, merely because they are cruelly oppressed by others? It is indeed true that the natives of Guinea cannot be made really free but by introducing among them the blessings of religion and the arts of civil life; but surely they would have fewer temptations than at present to kidnap one another, or to commence unprovoked wars for the purpose of making captives, were the nations of Europe to abandon the commerce in slaves (o). That commerce, we grant, would be continued by the Arabs, and perhaps by others of the eastern nations; but the same number of people could not be carried off by them alone that is now carried off both by them and by the Europeans.

‡ *Dalzel's History.*

37 of no strength.

Were it indeed possible to put the slave-trade under proper regulations, so as to prevent all kidnapping and unjust wars among the Africans, to supply the markets; and were it likewise possible to ensure to the negroes in the West Indies mild treatment and religious instruction; we are far from being sure that while the natives of Guinea continue so rude, and their neighbours the Arabs so selfishly savage, it would be proper to abandon at once to hordes of barbarians the whole of this commerce in bond servants. "The trade, which in its present form is a reproach to Britain, might be made to take a new shape, and become ultimately a blessing to thousands of wretches who, left in their native country, would have dragged out a life of miserable ignorance, unknowing the hand that framed them, unconscious of the reason of which they were made capable, and heedless of the happiness laid up for them in store §.

§ *Ramsay's Essay*, p. 292, &c.

Slavery is, indeed, in every form an evil; but it seems to be one of those many evils which, having long prevailed in the world, can be advantageously removed only by degrees, and as the moral cultivation of the slaves may enable them to support the rank and discharge the duties of free men. This is doubtless the reason why it was not expressly prohibited by the divine Author of our religion, but suffered to vanish gradually before the mild influence of his Heavenly doctrines. It has vanished before these doctrines in most countries of Europe; and it affords us no small gratification to have it in our power to record, what indeed must be fresh in the memory of our readers, that the abolition of the slave-trade was finally accomplished by the steady perseverance and generous exertions of some of the most enlightened and respectable characters in the kingdom, who, after a long and arduous struggle, obtained a decree of the legislature, prohibiting, after a limited period, the trade in slaves to be continued by subjects of Britain. The bill originated in the house of lords, and having undergone considerable discussion in the house of commons, finally passed on the 16th of March, and received his majesty's assent

38 Abolition of the slave-trade in Britain.

would be *advantageous* to the sugar-planters; for the planters surely understand their own interest better than those can do, who, having never been in the West Indies, are obliged to content themselves with what information they can glean on the subject from a number of violent and contradictory publications. To countenance slavery under any form is undoubtedly immoral. This we know: and therefore upon this ground have we opposed the slave-trade, which cannot be continued without preferring interest to virtue.

(o) In a speech which Mr Dalzel says the king of Dahomy made to Mr Abson, when he was informed of what had passed in England on the subject of the slave-trade, are these remarkable words: "In the name of my ancestors and myself, I aver that no Dahoman ever embarked in war merely for the sake of procuring wherewithal to purchase your commodities." We must take the liberty to question the truth of this solemn averment. That the slave-trade is not the *sole* cause of the Dahoman wars every man will admit, who does not fancy that those people have neither passions nor appetites, but for the commodities of Europe: but the bare affirmation of this bloody despot, who boasted of having killed many thousands at the *customs*, will not convince those who have read either Wadstrom's Essay on Colonization, or the evidence respecting the slave-trade given at the bar of the House of Commons, "that no Dahoman *ever* embarked in war merely to procure slaves to barter for European commodities."

Slave-trade ‖ Sleep-walker.

assent on the 25th March 1807. The time fixed by the bill, for the total abolition of the trade, we believe, was the beginning of the following year, viz. January 1808.

We cannot conclude without expressing a hope, that the period is not very distant when the slaves in the West Indies shall be so much improved in moral and religious knowledge, as that they may be safely trusted with their own freedom. To set them free in their present state of ignorance and depravity, is one of the wildest proposals that the ardour of innovation has ever made. Such freedom would be equally ruinous to themselves and to their masters; and we may say of it what Cicero said of some unseasonable indulgences proposed to be granted to the slaves in Sicily: *Quæ cum accidunt, nemo est, quin intelligat ruere illam rempublicam; hæc ubi veniunt, nemo est, qui ullam spem salutis reliquam esse arbitretur.*

39 Danger of a sudden manumission of slaves.

Those of our readers who wish to enter into a detail of this subject, may consult, with much advantage, The History of the Rise, Progress, and Accomplishment of the Abolition of the African Slave-Trade, by Mr Clarkson, 2 vols 8vo.

SLAUGHTER. See MANSLAUGHTER, HOMICIDE, MURDER, &c.

SLEDGE, a kind of carriage, without wheels, for the conveyance of very weighty things, as huge stones, bells, &c. The sledge for carrying criminals, condemned for high treason, to execution, is called HURDLE. The Dutch have a kind of sledge on which they can carry a vessel of any burden by land. It consists of a plank of the length of the keel of a moderate ship, raised a little behind, and hollow in the middle; so that the sides go a little aslope, and are furnished with holes to receive pins, &c. The rest is quite even.

SLEDGE is a large smith's hammer, to be used with both hands: of this there are two sorts, the up-hand sledge, which is used by under workmen, when the work is not of the largest sort; it is used with both the hands before, and they seldom raise it higher than their head. But the other, which is called the about-sledge, and which is used for battering or drawing out the largest work, is held by the handle with both hands, and swung round over their heads, at their arm's end, to strike as hard a blow as they can.

SLEEP, that state of the body in which, though the vital functions continue, the senses are not affected by the ordinary impressions of external objects. See DREAMS and PHYSIOLOGY.

SLEEP-Walker, one who walks in his sleep. Many instances might be related of persons who were addicted to this practice; but it will be sufficient to select one remarkable instance from a report made to the Physical Society of Lausanne, by a committee of gentlemen appointed to examine a young man who was accustomed to walk in his sleep.

"The disposition to sleep-walking seems, in the opinion of this committee, to depend on a particular affection of the nerves, which both seizes and quits the patient during sleep. Under the influence of this affection, the imagination represents to him the objects that struck him while awake, with as much force as if they really affected his senses; but does not make him perceive any of those that are actually presented to his senses, except in so far as they are connected with the dreams which engross him at the time. If, during this state, the imagination has no determined purpose, he receives the impression of objects as if he were awake; only, however, when the imagination is excited to bend its attention towards them. The perceptions obtained in this state are very accurate, and, when once received, the imagination renews them occasionally with as much force as if they were again acquired by means of the senses. Lastly, these academicians suppose, that the impressions received during this state of the senses disappear entirely when the person awakes, and do not return till the return of the same disposition in the nervous system.

Sleep-walker.

"Their remarks were made on the Sieur Devaud, a lad thirteen years and a half old, who lives in the town of Vevey, and who is subject to that singular affection or disease called *Somnambulism* or sleep-walking. This lad possesses a strong and robust constitution, but his nervous system appears to be organised with peculiar delicacy, and to discover marks of the greatest sensibility and irritability. His senses of smell, taste, and touch, are exquisite; he is subject to fits of immoderate and involuntary laughter, and he sometimes likewise weeps without any apparent cause.

"This young man does not walk in his sleep every night; several weeks sometimes pass without any appearance of a fit. He is subject to the disease generally two nights successively, one fit lasting for several hours. The longest are from three to four hours, and they commonly begin about three or four o'clock in the morning.

"The fit may be prolonged, by gently passing the finger or a feather over his upper lip, and this slight irritation likewise accelerates it. Having once fallen asleep upon a staircase, his upper lip was thus irritated with a feather, when he immediately ran down the steps with great precipitation, and resumed all his accustomed activity. This experiment was repeated several times.

"The young Devaud thinks he has observed, that, on the evenings previous to a fit, he is sensible of a certain heaviness in his head, but especially of a great weight in his eyelids.

"His sleep is at all times unquiet, but particularly when the fits are about to seize him. During his sleep, motions are observable in every part of his body, with starting and palpitations; he utters broken words, sometimes sits up in his bed, and afterwards lies down again. He then begins to pronounce words more distinctly, he rises abruptly, and acts as he is instigated by the dream that then possesses him. He is sometimes in sleep subject to continued and involuntary motions.

"The departure of the fit is always preceded by two or three minutes of calm sleep, during which he snores. He then awakes rubbing his eyes like a person who has slept quietly.

"It is dangerous to awaken him during the fit, especially if it is done suddenly; for then he sometimes falls into convulsions. Having risen one night with the intention of going to eat grapes, he left the house, passed through the town, and went to a vineyard where he expected good cheer. He was followed by several persons, who kept at some distance from him, one of whom fired a pistol, the noise of which instantly awakened him, and he fell down without sense. He was carried home and brought to himself, when he recollected very well the

having

having been awakened in the vineyard; but nothing more, except the fright at being found there alone, which had made him ſwoon.

"After the fits he generally feels a degree of laſſitude: ſometimes, though rarely, of indiſpoſition. At the end of one of thoſe fits, of which the gentlemen of the committee were witneſſes, he was affected with vomitings; but he is always ſoon reſtored.

"When he is awaked, he never for the moſt part recollects any of the actions he has been doing during the fit.

"The ſubject of his dreams is circumſcribed in a ſmall circle of objects, that relate to the few ideas with which at his age his mind is furniſhed; ſuch as his leſſons, the church, the bells, and eſpecially tales of ghoſts. It is ſufficient to ſtrike his imagination the evening before a fit with ſome tale, to direct his ſomnambuliſm towards the object of it. There was read to him while in this ſituation the ſtory of a robber; he imagined the very next moment that he ſaw robbers in the room. However, as he is much diſpoſed to dream that he is ſurrounded with them, it cannot be affirmed that this was an effect of the reading. It is obſerved, that when his ſupper has been more plentiful than uſual, his dreams are more diſmal.

"In their report, the gentlemen of the committee dwell much on the ſtate of this young man's ſenſes, on the impreſſion made upon them by ſtrange objects, and on the uſe they are of to him.

"A bit of ſtrong ſmelling wood produced in him a degree of reſtleſſneſs; the fingers had the ſame effect, whether from their ſmell or their tranſpiration. He knew wine in which there was wormwood by the ſmell, and ſaid that it was not wine for his table. Metals make no impreſſion on him.

"Having been preſented with a little common wine while he was in a ſtate of apathy, and all his motions were performed with languor, he drank of it willingly; but the irritation which it occaſioned produced a deal of vivacity in all his words, motions, and actions, and cauſed him to make involuntary grimaces.

"Once he was obſerved dreſſing himſelf in perfect darkneſs. His clothes were on a large table, mixed with thoſe of ſome other perſons; he immediately perceived this, and complained of it much; at laſt a ſmall light was brought, and then he dreſſed himſelf with ſufficient preciſion. If he is teaſed or gently pinched, he is always ſenſible of it, except he is at the time ſtrongly engroſſed with ſome other thing, and wiſhes to ſtrike the offender; however, he never attacks the perſon who has done the ill, but an ideal being whom his imagination preſents to him, and whom he purſues through the chamber without running againſt the furniture, nor can the perſons whom he meets in his way divert him from his purſuit.

"While his imagination was employed on various ſubjects, he heard a clock ſtrike, which repeated at every ſtroke the note of the cuckoo. There are cuckoos here, ſaid he; and, upon being deſired, he imitated the ſong of that bird immediately.

"When he wiſhes to ſee an object, he makes an effort to lift his eyelids; but they are ſo little under his command, that he can hardly raiſe them a line or two, while he draws up his eyebrows; the iris at that time appears fixed, and his eye dim. When any thing is preſented to him, and he is told of it, he always half opens his eyes with a degree of difficulty, and then ſhuts them after he has taken what was offered to him.

"The report infers from theſe facts, and from many others relative to the different ſenſes, that their functions are not ſuſpended as to what the ſleep-walker wiſhes to ſee, that is, as to all thoſe perceptions which accord with the objects about which his imagination is occupied; that he may alſo be diſpoſed to receive thoſe impreſſions, when his imagination has no other object at the time; that in order to ſee, he is obliged to open his eyes as much as he can, but when the impreſſion is once made, it remains; that objects may ſtrike his ſight without ſtriking his imagination, if it is not intereſted in them; and that he is ſometimes informed of the preſence of objects without either ſeeing or touching them.

"Having engaged him to write a theme, ſay the committee, we ſaw him light a candle, take pen, ink, and paper, from the drawer of his table, and begin to write, while his maſter dictated. As he was writing, we put a thick paper before his eyes, notwithſtanding which he continued to write and to form his letters very diſtinctly; ſhowing ſigns, however, that ſomething was incommoding him, which apparently proceeded from the obſtruction which the paper, being held too near his noſe, gave to his reſpiration.

"Upon another occaſion, the young ſomnambuliſt aroſe at five o'clock in the morning, and took the neceſſary materials for writing, with his copy-book. He meant to have begun at the top of a page; but finding it already written on, he came to the blank part of the leaf, and wrote ſome time from the following words, *Fiunt ignari pigritia—Ils deviennent ignorans par la pareſſe;* and, what is remarkable, after ſeveral lines he perceived he had forgot the *s* in the word *ignorans*, and had put erroneouſly a double *r* in *pareſſe;* he then gave over writing, to add the *s* he had forgotten, and to eraſe the ſuperfluous *r*.

"Another time he had made, of his own accord, a piece of writing, in order, as he ſaid, to pleaſe his maſter. It conſiſted of three kinds of writing, text, half text, and ſmall writ; each of them performed with the proper pen. He drew, in the corner of the ſame paper, the figure of a hat; he then aſked for a penknife to take out a blot of ink which he had made between two letters, and he eraſed it without injuring them. Laſtly, he made ſome arithmetical calculations with great accuracy.

"In order to explain ſome of the facts obſerved by the academicians which we have here mentioned, they eſtabliſh two general obſervations, which reſult from what they have ſaid with reſpect to the ſenſes and the dreams of this ſleep-walker.

"1. That he is obliged to open his eyes, in order to recogniſe objects which he wiſhes to ſee; but the impreſſion once made, although rapidly, is vivid enough to ſuperſede the neceſſity of his opening them again, to view the ſame objects anew; that is, the ſame objects are afterwards preſented to his imagination with as much force and preciſion as if he actually ſaw them.

"2. That his imagination, thus warmed, repreſents to him objects, and ſuch as he figures to himſelf, with as much vivacity as if he really ſaw them; and, laſtly, that all his ſenſes, being ſubordinate to his imagination, ſeem feem concentrated in the object with which it is occupied, and have at that time no perception of any thing but what relates to that object.

"Thefe two caufes united feem to them fufficient for explaining one of the moft fingular facts that occurred to their obfervation, to wit, how the young Devaud can write, although he has his eyes fhut, and an obftacle before them. His paper is imprinted on his imagination, and every letter which he means to write is alfo painted there, at the place in which it ought to ftand on the paper, and without being confounded with the other letters; now it is clear that his hand, which is obedient to the will of his imagination, will trace them on the real paper, in the fame order in which they are reprefented on that which is pictured in his head. It is thus that he is able to write feveral letters, feveral fentences, and entire pieces of writing; and what feems to confirm the idea, that the young Devaud writes according to the paper painted on his imagination is, that a certain fleep-walker, who is defcribed in the French *Encyclopédie* (article *Somnambulifm*), having written fomething on a paper, another piece of paper of the fame fize was fubftituted in its ftead, which he took for his own, and made upon this blank paper the corrections he meant to have made on the other which had been taken away, precifely in the places where they would have been.

"It appears from the recital of another fact, that Devaud, intending to write at the top of the firft leaf of a white paper book, *Vevey, le*— ftopped a moment as if to recollect the day of the month, left a blank fpace, and then proceeded to *Decembre* 1787; after which he afked for an almanac: a little book, fuch as is given to children for a new year's gift, was offered to him; he took it, opened it, brought it near his eyes, then threw it down on the table. An almanac which he knew was then prefented to him; this was in German, and of a form fimilar to the almanac of Vevey: he took it, and then faid, 'What is this they have given me; here, there is your German almanac.' At laft they gave him the almanac of Berne; he took this likewife, and went to examine it at the bottom of an alcove that was perfectly dark. He was heard turning over the leaves, and faying 24, then a moment afterwards 34. Returning to his place, with the almanac open at the month of December, he laid it on the table and wrote in the fpace which he had left blank the 24th. This fcene happened on the 23d; but as he imagined it to be the 24th, he did not miftake. The following is the explication given of this fact by the authors of the report.

"The dates 23d, 24th, and 25th, of the month of December, had long occupied the mind of the young Devaud. The 23d and 25th were holidays, which he expected with the impatience natural to perfons of his age, for the arrival of thofe moments when their little daily labours are to be fufpended. The 25th efpecially was the object of his hopes; there was to be an illumination in the church, which had been defcribed to him in a manner that quite tranfported him. The 24th was a day of labour, which came very difagreeably between the two happy days. It may eafily be conceived, how an imagination fo irritable as that of the young Devaud would be ftruck with thofe pleafing epochs. Accordingly, from the beginning of the month he had been perpetually turning over the almanac of Vevey. He calculated the days and the hours that were to elapfe before the arrival of his wifhed-for holidays; he fhowed to his friends and acquaintance the dates of thofe days which he expected with fo much impatience; every time he took up the almanac, it was only to confult the month of December. We now fee why that date prefented itfelf to his mind. He was performing a tafk, becaufe he imagined the day to be the Monday which had fo long engroffed him. It is not furprifing, that it fhould have occurred to his imagination, and that on opening the almanac in the dark he might have thought he faw this date which he was feeking, and that his imagination might have reprefented it to him in as lively a manner as if he had actually feen it. Neither is it furprifing that he fhould have opened the almanac at the month of December; the cuftom of perufing this month muft have made him find it in the dark by a mere mechanical operation. Man never feems to be a machine fo much as in the ftate of fomnambulifm; it is then that habit comes to fupply thofe of the fenfes that cannot be ferviceable, and that it makes the perfon act with as much precifion as if all his fenfes were in the utmoft activity. Thefe circumftances deftroy the idea of there being any thing miraculous in the behaviour of young Devaud with refpect to the date and the month that he was in queft of; and the reader, who has entered into our explanations, will not be furprifed at his knowing the German almanac; the touch alone was fufficient to point it out to him; and the proof of this is the fhortnefs of the time that it remained in his hands.

"An experiment was made by changing the place of the ink-ftandifh during the time that Devaud was writing. He had a light befide him, and had certified himfelf of the place where his ink-holder was ftanding by means of fight. From that time he continued to take ink with precifion, without being obliged to open his eyes again: but the ink ftandifh being removed, he returned as ufual to the place where he thought it was: It muft be obferved, that the motion of his hand was rapid till it reached the height of the ftandifh, and then he moved it flowly, till the pen gently touched the table as he was feeking for the ink: he then perceived that a trick had been put on him, and complained of it; he went in fearch of his ink-ftandifh and put it in its place. This experiment was feveral times repeated, and always attended with the fame circumftances. Does not what we have here ftated prove, that the ftandifh, the paper, the table, &c. are painted on his imagination in as lively a manner as if he really faw them, as he fought the real ftandifh in the place where his imagination told him it ought to have been? Does it not prove that the fame lively imagination is the caufe of the moft fingular actions of this fleep-walker? And laftly, does it not prove, that a mere glance of his eye is fufficient to make his impreffions as lively as durable?

"The committee, upon the whole, recommend to fuch as wifh to repeat the fame experiments, 1. To make their obfervations on different fleep-walkers. 2. To examine often whether they can read books that are unknown to them in perfect darknefs. 3. To obferve whether they can tell the hours on a watch in the dark. 4. To remove when they write the ink-ftandifh from its place, to fee whether they will return to the fame place in in order to take ink. 5. And, laftly, to take notice whether they walk with the fame confidence in a dark and unknown place, as in one with which they are acquainted.

"They likewife recommend to fuch as would confirm or invalidate the above obfervations, to make all their experiments in the dark; becaufe it has been hitherto fuppofed that the eyes of fleep-walkers are of no ufe to them."

SLEEPERS, in *Natural Hiftory*, a name given to thofe animals which fleep all winter; fuch as bears, marmots, dormice, bats, hedgehogs, fwallows, &c. Thefe do not feed in winter, have no fenfible evacuations, breathe little or none at all, and moft of the vifcera ceafe from their functions. Some of thefe animals feem to be dead, and others return to a ftate like that of the fœtus before birth: in this ftate they continue, till by an increafe of heat the animal is reftored to its former functions.

SLEEPERS, in a fhip, timbers lying before and aft in the bottom of the fhip, as the rungheads do: the lowermoft of them is bolted to the rungheads, and the uppermoft to the futtocks and rungs.

SLEIDAN, JOHN, an excellent German hiftorian, born of obfcure parents, in 1506, at Sleidan, a fmall town on the confines of the duchy of Juliers. After ftudying fome time in his own country, together with his townfman the learned John Sturmius, he went to France, and in 1525 entered into the fervice of the cardinal and archbifhop John du Bellay. He retired to Strafburg in 1542, where he acquired the efteem and friendfhip of the moft confiderable perfons, particularly of James Sturmius; by whofe advice and affiftance he was enabled to write the hiftory of his own time. He was employed in fome public negociations; but the death of his wife, in 1555, plunged him into fo deep a melancholy, that he loft his memory entirely, and died the year following. In 1555 came out, in folio, *De ftatu Religionis et Reipublicæ fub Carolo Quinto*, &c. in 15 books; from the year 1517, when Luther began to preach, to the year of its publication; which hiftory was prefently tranflated into moft of the languages of Europe. Befides this great work, he wrote, *De quatuor fummis Imperiis, libri tres;* with fome other hiftorical and political pieces.

SLEIGHT *of* HAND. See LEGERDEMAIN.

SLESWICK, an ancient and confiderable town of Denmark, the metropolis of a duchy of the fame name, in the province of Gottorp, the fee of a bifhop, which was fecularized in the year 1586. The old palace of Gottorp is clofe to it, which was formerly the ducal refidence, but afterwards inhabited by the governor. This town at one period was much more extenfive than it is now, having fuffered greatly by the German wars. It is feated on the gulf of Sley, where there is a commodious harbour, 60 miles north-weft of Lubeck, and 125 fouth-weft of Copenhagen. The people boaft that the German language is here fpoken with as much accuracy as at Vienna, of which, however, a good German fcholar can alone be judge. Slefwick has but little trade, as none but fmall boats can have accefs to it, the paffage of the Sley having been long fince chocked up with fand and mud; before which period it was both flourifhing and populous. It is now chiefly inhabited by the officers of the caftle, and the poorer claffes, or the attendants on the court and on them. The prefent population is faid not to exceed 5000. E. Long. 10. 0. N. Lat. 54. 40.

SLESWICK, the duchy of, or *South Jutland*, is about 100 miles in length and 60 in breadth. It is bounded on the north by North Jutland, on the eaft by the Baltic fea, on the fouth by Holftein, and on the weft by the ocean. It contains 14 cities, 17 towns, 13 caftles, 278 parifhes, 1480 villages, 162 farms, 116 water-mills, and 106 gentlemen's feats. It is a pleafant, fertile, populous country, and a fovereign duchy. Formerly the king of Denmark had half of it, and the other belonged to the houfe of Holftein-Gottorp; but the former having conquered this duchy, had the poffeffion of it confirmed to him by the treaty of the north in 1720. In 1731, a prince of Bareith-Culmbach was made governor of this duchy, who refides at Gottorp.

SLEUT-HOUNDE, the ancient Scots name of the blood-hound. The word is from the Saxon *flot*, "the impreffion that a deer leaves of its foot in the mire," and *hound*, "a dog"; fo they derive their name from following the track. See the article *BLOOD-Hound*.

SLICH, in *Metallurgy*, the ore of any metal, particularly of gold, when it has been pounded, and prepared for farther working.

The manner of preparing the flich at Chremnitz in Hungary is this; they lay a foundation of wood three yards deep, upon this they place the ore, and over this there are 24 beams, armed at their bottoms with iron; thefe, by a continual motion, beat and grind the ore, till it is reduced to powder: during this operation, the ore is covered with water. There are four wheels ufed to move thefe beams, each wheel moving fix; and the water, as it runs off, carrying fome of the metalline particles with it, is received into feveral bafons, one placed behind another; and finally, after having paffed through them all, and depofited, fome fediment in each, it is let off into a very large pit, almoft half an acre in extent; in which it is fuffered to ftand fo long, as to depofit all its fediment, of whatever kind, and after this it is let out. This work is carried on day and night, and the ore taken away and replaced by more as often as occafion requires. That ore which lies next the beams, by which it was pounded, is always the cleaneft or richeft.

When the flich is wafhed as much as they can, a hundred weight of it ufually contains about an ounce, or perhaps but half an ounce of metal, which is not all gold; for there is always a mixture of gold and filver, but the gold is in the largeft quantity, and ufually is two-thirds of the mixture: they then put the flich into a furnace with fome limeftone, and flacken, or the fcoria of former meltings, and run them together. The firft melting produces a fubftance called *lech;* this lech they burn with charcoal, to make it lighter, to open its body, and render it porous, after which it is called *roft;* to this roft they add fand in fuch quantity as they find neceffary, and then melt it over again.

At Chremnitz many other ways are practifed of reducing gold out of its ore, but particularly one, in which they employ no lead during the whole operation; whereas, in general, lead is always neceffary, after the beforementioned proceffes. See *ORES, Reduction of*.

SLIDING RULE, a mathematical inftrument, ferving to work queftions in gauging, meafuring, &c. without

out the use of compasses; merely by the sliding of the parts of the instrument one by another, the lines and divisions whereof give the answer by inspection.

This instrument is variously contrived, and applied by various authors, particularly Everard, Coggeshall, Gunter, Hunt, and Partridge; but the most common and useful are those of Everard and Coggeshall.

SLIGO, a county in the province of Connaught, Ireland, 25 miles in length, and as much in breadth; bounded on the east by that of Leitrim, on the west by the county of Mayo, on the north and north-west by the western ocean, and on the south and south-west by Roscommon and Mayo. It contains 5970 houses, 41 parishes, 6 baronies, 1 borough, and sends 4 members to parliament, two for the county, and two for the borough of the same name, which is the only market-town in the county, and is seated on a bay of the same name, 30 miles west of Killalla, and 110 north-east of Dublin. W. Long. 8. 26. N. Lat. 54. 13.

SLING, an instrument serving for casting stones with great violence. The inhabitants of the Balearic islands were famous in antiquity for the dexterous management of the sling; it is said they used three kinds of slings, some longer, others shorter, which they used according as their enemies were either nearer or more remote. It is added, that the first served them for a head-band, the second for a girdle, and that the third they constantly carried in their hand.

SLINGING is used variously at sea; but chiefly for hoisting up casks or other heavy things with slings, *i. e.* contrivances of ropes spliced into themselves at either end, with one eye big enough to receive the cask or whatever is to be slung. There are other slings, which are made longer, and with a small eye at each end; one of which is put over the breech of a piece of ordnance, and the other eye comes over the end of an iron crow, which is put into the mouth of the piece, to weigh and hoise the gun as they please. There are also slings by which the yards are bound fast to the cross-tree aloft, and to the head of the mast, with a strong rope or chain, that if the tie should happen to break, or to be shot to pieces in fight, the yard, nevertheless, may not fall upon the hatches.

SLINGING a Man overboard, in order to stop a leak in a ship, is done thus: the man is trussed up about the middle in a piece of canvas, and a rope to keep him from sinking, with his arms at liberty, a mallet in one hand and a plug, wrapped in oakum and well tarred in a tarpawling clout, in the other, which he is to beat with all dispatch into the hole or leak.

SLOANE, Sir Hans, Baronet, eminently distinguished as a physician and a naturalist, was of Scotch extraction, his father Alexander Sloane being at the head of that colony of Scots which King James I. settled in the north of Ireland, where our author was born, at Killieagh, on the 19th of April 1660. At a very early period, he displayed a strong inclination for natural history; and this propensity being encouraged by a suitable education, he employed those hours which young people generally lose by pursuing low and trifling amusements, in the study of nature, and contemplating her works. When about sixteen, he was attacked by a spitting of blood, which threatened to be attended with considerable danger, and which interrupted the regular course of his application for three years; he had, however, already learned enough of physic to know that a malady of this kind was not to be removed suddenly, and he prudently abstained from wine and other liquors that were likely to increase it.

By strictly observing this severe regimen, which in some measure he continued ever after, he was enabled to prolong his life beyond the ordinary bounds; being an example of the truth of his own favourite maxim, that sobriety, temperance, and moderation, are the best and most powerful preservatives that nature has granted to mankind.

As soon as he recovered from this infirmity, he resolved to perfect himself in the different branches of physic, which was the profession he had made choice of; and with this view he repaired to London, where he hoped to receive that assistance which he could not find in his own country.

On his arrival in the metropolis, he entered himself as a pupil to the great Stafforth, an excellent chemist, bred under the illustrious Stahl; and by his instructions he gained a perfect knowledge of the composition and preparation of the different kinds of medicines then in use. At the same time, he studied botany at the celebrated garden at Chelsea, assiduously attended the public lectures of anatomy and physic, and in short neglected nothing that he thought likely to prove serviceable to him in his future practice. His principal merit, however, was his knowledge of natural history; and it was this part of his character which introduced him early to the acquaintance of Mr Boyle and Mr Ray, two of the most eminent naturalists of that age. His intimacy with these distinguished characters continued as long as they lived; and as he was careful to communicate to them every object of curiosity that attracted his attention, the observations which he occasionally made often excited their admiration and obtained their applause.

After studying four years at London with unremitting severity, Mr Sloane determined to visit foreign countries for farther improvement. In this view he set out for France in the company of two other students, and having crossed to Dieppe, proceeded to Paris. In the way thither they were elegantly entertained by the famous M. Lemery the elder; and in return Mr Sloane presented that eminent chemist with a specimen of four different kinds of phosphorus, of which, upon the credit of other writers, M. Lemery had treated in his book of chemistry, though he had never seen any of them.

At Paris Mr Sloane lived as he had done in London. He attended the hospitals, heard the lectures of Tournefort, De Verney, and other eminent masters; visited all the literati, who received him with particular marks of esteem, and employed himself wholly in study.

From Paris Mr Sloane went to Montpelier; and, being furnished with letters of recommendation from M. Tournefort to M. Chirac, then chancellor of that university, he found easy access, through his means, to all the learned men of the province, particularly to M. Magnol, whom he always accompanied in his botanical excursions in the environs of that city, where he beheld with pleasure and admiration the spontaneous productions of nature, and learned under his instructions to class them in a proper manner.

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Having here found an ample field for contemplation, which was entirely suited to his taste, he took leave of his two companions, whom a curiosity of a different kind led into Italy.

After spending a whole year in collecting plants, he travelled through Languedoc with the same design; and passing through Thoulouse and Bourdeaux, returned to Paris, where he made a short stay. About the end of the year 1684 he set out for England, with an intention of settling there as a physician. On his arrival in London, he made it his first business to visit his two illustrious friends Mr Ray and Mr Boyle, in order to communicate to them the discoveries he had made in his travels. The latter he found at home, but the former had retired to Essex; to which place Mr Sloane transmitted a great variety of plants and seeds, which Mr Ray has described in his History of Plants, and for which he makes a proper acknowledgement.

About the year 1706 our author became acquainted with the celebrated Sydenham; who soon contracted so warm an affection for him that he took him into his house, and recommended him in the strongest manner to his patients. He had not been long in London before he was proposed by Dr Martin Lister as a candidate to be admitted a member of the Royal Society, on the 26th of November 1684; and being approved, he was elected on the 21st of January following.

In 1685 he communicated some curiosities to the Society; and in July the same year he was a candidate for the office of their assistant secretary, but without success, as he was obliged to give way to the superior interest of his competitor Dr Halley. On the 12th of April 1687, he was chosen a fellow of the college of physicians in London; and the same year his friend and fellow traveller Dr Tancred Robinson, having mentioned to the Society the plant called the *star of the earth*, as a remedy newly discovered for the bite of a mad dog, Dr Sloane acquainted them that this virtue of the plant was to be found in a book called *De Grey's Farriery*; and that he knew a man who had cured with it twenty couple of dogs. This observation he made on the 13th of July, and on the 12th of September following he embarked at Portsmouth for Jamaica with the duke of Albemarle, who had been appointed governor of that island. The doctor attended his grace in quality of physician, and arrived at Jamaica on the 19th of December following.

Here a new field was opened for fresh discoveries in natural productions; but the world would have been deprived of the fruits of them, had not our author, by incredible application, converted, as we may say, his minutes into hours. The duke of Albemarle died soon after he landed, and the duchess determined to return to England whenever an answer should be received to the letter she had sent to court on that melancholy occasion. As Dr Sloane could not think of leaving her grace in her distress, whilst the rest of her retinue were preparing for their departure he improved it in making collections of natural curiosities; so that though his whole stay at Jamaica was not above fifteen months, he brought together such a prodigious number of plants, that on his return to England Mr Ray was astonished that one man could procure in one island, and in so short a space, so vast a variety.

On his arrival in London he applied himself to the practice of his profession; and soon became so eminent, that he was chosen physician to Christ's Hospital on the 17th October 1694: and this office he held till the year 1730, when, on account of his great age and infirmities, he found it necessary to resign. It is somewhat singular, and redounds much to the Doctor's honour, that though he received the emoluments of his office punctually, because he would not lay down a precedent which might hurt his successors, yet he constantly applied the money to the relief of those who were the greatest objects of compassion in the hospital, that it might never be said he enriched himself by giving health to the poor. He had been elected secretary to the Royal Society on the 30th of November 1693; and upon this occasion he revived the publication of the Philosophical Transactions, which had been omitted for some time. He continued to be the editor of this work till the year 1712; and the volumes which appeared during that period are monuments of his industry and ingenuity, many of the pieces contained in them being written by himself.

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In the mean time he published *Catalogus Plantarum quæ in Insula Jamaica sponte proveniunt*, &c.; *seu Prodromi Historiæ Naturalis pars prima*; which he dedicated to the Royal Society and College of Physicians. About the same time he formed the plan of a dispensary, where the poor might be furnished at prime cost with such medicines as their several maladies might require; which he afterwards carried into execution, with the assistance of the president and other members of the college of physicians.

Our author's thirst for natural knowledge seems to have been born with him, so that his cabinet of curiosities may be said to have commenced with his being. He was continually enriching and enlarging it; and the fame which, in the course of a few years, it had acquired, brought every thing that was curious in art or nature to be first offered to him for purchase. These acquisitions, however, increased it but very slowly in comparison of the augmentation it received in 1701 by the death of William Courten, Esq. a gentleman who had employed all his time, and the greater part of his fortune, in collecting rarities, and who bequeathed the whole to Dr Sloane, on condition of his paying certain debts and legacies with which he had charged it. These terms our author accepted, and he executed the will of the donor with the most scrupulous exactness; on which account some people have said, that he purchased Mr Courten's curiosities at a dear rate.

In 1707 the first volume of Dr Sloane's Natural History of Jamaica appeared in folio, though the publication of the second was delayed till 1725. By this very useful as well as magnificent work, the materia medica was enriched with a great number of excellent drugs not before known. In 1708 the Doctor was elected a foreign member of the Royal Academy of Sciences at Paris, in the room of Mr Tschirnaus; an honour so much the greater, as we were then at war with France, and the queen's express consent was necessary before he could accept it. In proportion as his credit rose among the learned, his practice increased among the people of rank: Queen Anne herself frequently consulted him, and in her last illness was blooded by him.

On the advancement of George I. to the throne, that prince, on the 3d of April 1716, created the Doctor a baronet, an hereditary title of honour to which

no

Sloane. no English physician had before attained; and at the same time made him physician general to the army, in which station he continued till 1727, when he was appointed physician in ordinary to George II. He attended the royal family till his death; and was particularly favoured by Queen Caroline, who placed the greatest confidence in his prescriptions. In the mean time he had been unanimously chosen one of the elects of the college of physicians June 1. 1716, and he was elected president of the same body on September 30. 1719, an office which he held for sixteen years. During that period he not only gave the highest proofs of his zeal and assiduity in the discharge of his duty, but in 1721 made a present to that society of 100l.; and so far remitted a very considerable debt, which the corporation owed him, as to accept it in such small sums as were least inconvenient to the state of their affairs. Sir Hans was no less liberal to other learned bodies. He had no sooner purchased the manor of Chelsea, than he gave the company of apothecaries the entire freehold of their botanical garden there, upon condition only that they should present yearly to the Royal Society fifty new plants, till the number should amount to 2000 (A). He gave besides several other considerable donations for the improvement of this garden; the situation of which, on the banks of the Thames, and in the neighbourhood of the capital, was such as to render it useful in two respects: First, by producing the most rare medicinal plants; and, secondly, by serving as an excellent school for young botanists; an advantage which he himself had derived from it in the early part of his life.

The death of Sir Isaac Newton, which happened in 1727, made way for the advancement of Sir Hans to the presidency of the Royal Society. He had been vice-president, and frequently sat in the chair for that great man; and by his long connection with this learned body he had contracted so strong an affection for it, that he made them a present of an hundred guineas, caused a curious bust of King Charles II. its founder, to be erected in the great hall where it met, and, as is said, was very instrumental in procuring Sir Godfrey Copley's benefaction of a medal of the value of five guineas, to be annually given as an honorary mark of distinction to the person who communicates the best experiments to the Society.

On his being raised to the chair, Sir Hans laid aside all thoughts of further promotion, and applied himself wholly to the faithful discharge of the duties of the offices which he enjoyed. In this laudable occupation he employed his time from 1727 to 1740, when, at the age of fourscore, he formed a resolution of quitting the service of the public, and of living for himself. With this view he resigned the presidency of the Royal Society much against the inclination of that respectable body, who chose Martin Folkes, Esq. to succeed him, and in a public assembly thanked him for the great and eminent services he had rendered them. In the month of January 1741, he began to remove his library, and his cabinet of rarities, from his house in Bloomsbury to that at Chelsea; and on the 12th of March following, having settled all his affairs, he retired thither himself, to enjoy in peaceful tranquillity the remains of a well-spent life. He did not, however, bury himself in that solitude which excludes men from society. He received at Chelsea, as he had done in London, the visits of people of distinction, of all learned foreigners, and of the royal family, who sometimes did him the honour to wait on him; but, what was still more to his praise, he never refused admittance or advice to rich or poor who came to consult him concerning their health. Not contented with this contracted method of doing good, he now, during his retreat, presented to the public such useful remedies as success had warranted, during the course of a long continued practice. Among these is the efficacious receipt for distempers in the eyes, and his remedy for the bite of a mad dog.

During the whole course of his life, Sir Hans had lived with so much temperance, as had preserved him from feeling the infirmities of old age; but in his 90th year he began to complain of pains, and to be sensible of an universal decay. He was often heard to say, that the approach of death brought no terrors along with it; that he had long expected the stroke; and that he was prepared to receive it whenever the great Author of his being should think fit. After a short illness of three days, he died on the 11th of January 1752, and was interred on the 18th at Chelsea, in the same vault with his lady, the solemnity being attended with the greatest concourse of people, of all ranks and conditions, that had ever been seen before on the like occasion.

Sir Hans being extremely solicitous lest his cabinet of curiosities, which he had taken so much pains to collect, should be again dissipated at his death, and being at the same time unwilling that so large a portion of his fortune should be lost to his children, he bequeathed it to the public, on condition that 20,000l. should be made good by parliament to his family. This sum, though large in appearance, was scarcely more than the intrinsic value of the gold and silver medals, the ores and precious stones that were found in it; for in his last will he declares, that the first cost of the whole amounted at least to 50,000l. Besides his library, consisting

(A) This garden was first established by the company in 1673; and having after that period been stocked by them with a great variety of plants, for the improvement of botany, Sir Hans, in order to encourage so serviceable an undertaking, granted to the company the inheritance of it, being part of his estate and manor of Chelsea, on condition that it should be for ever preserved as a physic garden. As a proof of its being so maintained, he obliged the company, in consideration of the said grant, to present yearly to the Royal Society, in one of their weekly meetings, fifty specimens of plants that had grown in the garden the preceding year, and which were all to be specifically distinct from each other, until the number of two thousand should be completed. This number was completed in the year 1761. In 1733 the company erected a marble statue of Sir Hans, executed by Rysbrac, which is placed upon a pedestal in the centre of the garden, with a Latin inscription, expressing his donation, and the design and advantages of it.

fifting of more than 50,000 volumes, 347 of which were illuftrated with cuts finely engraven and coloured from nature, there were 3560 manufcripts, and an infinite number of rare and curious works of every kind. The parliament accepted the legacy, and fulfilled the conditions.

SLOANEA, a genus of plants belonging to the clafs of polyandria, and order of monogynia; and in the natural fyftem ranging under the 50th order, *Amentaceæ*. See BOTANY *Index*.

SLOE. See PRUNUS, BOTANY *Index*.

SLOOP, a fmall veffel furnifhed with one maft, the mainfail of which is attached to a gaff above, or to the maft on its foremoft edge, and to a long boom below, by which it is occafionally fhifted to either quarter. See SHIP.

SLOOP of War, a name given to the fmalleft veffels of war except cutters. They are either rigged as fhips or fnows.

SLOT, in the fportfman's language, a term ufed to exprefs the mark of the foot of a ftag or other animal proper for the chace in the clay or earth, by which they are able to guefs when the animal paffed, and which way he went. The flot, or treading of the ftag, is very nicely ftudied on this occafion; if the flot be large, deep printed in the ground, and with an open cleft, and, added to thefe marks, there is a large fpace between mark and mark, it is certain that the ftag is an old one. If there be obferved the flots or treadings of two, the one long and the other round, and both of one fize, the long flot is always that of the larger animal. There is alfo another way of knowing the old ones from the young ones by the treading; which is, that the hinder feet of the old ones never reach to their fore feet, whereas thofe of the young ones do.

SLOTH. See BRADYPUS, MAMMALIA *Index*.

SLOUGH, a deep muddy place. The caft fkin of a fnake, the damp of a coal pit, and the fcar of a wound, are alfo called by the fame appellation. The flough of a wild boar is the bed, foil, or mire, wherein he wallows, or in which he lies in the day-time.

SLUCZK, a large and populous town in Poland, in Lithuania, and capital of a duchy of the fame name; famous for three battles gained here by Conftantine duke of Oftrog over the Tartars, in the reign of Sigifmund I. It is feated on the river Sluczk, 72 miles fouth-eaft of Minfki, and 70 fouth of Novogrodeck. E. Long. 27. 44. N. Lat. 53. 2.

SLUG. See LIMAX, HELMINTHOLOGY *Index*.

SLUICE, a frame of timber, ftone, or other matter, ferving to retain and raife the water of a river, &c. and on occafion to let it pafs.

Such is the fluice of a mill, which ftops and collects the water of a rivulet, &c. to let it fall at length in the greater plenty upon the mill-wheel; fuch alfo are thofe ufed as vents or drains to difcharge water off land. And fuch are the fluices of Flanders, &c. which ferve to prevent the waters of the fea from overflowing the lower lands.

Sometimes there is a kind of canal inclofed between two gates or fluices, in artificial navigations, to fave the water, and render the paffage of boats equally eafy and fafe, upwards and downwards; as in the fluices of Briare in France, which are a kind of maffive walls built parallel to each other, at the diftance of 20 or 24 feet, clofed with ftrong gates at each end, between which is a kind of canal or chamber, confiderably longer than broad; wherein a veffel being inclofed, the water is let out at the firft gate, by which the veffel is raifed 15 or 16 feet, and paffed out of this canal into another much higher. By fuch means a boat is conveyed out of the Loire into the Seine, though the ground between them rife above 150 feet higher than either of thofe rivers *.

* See Canal.

Sluices are made different ways, according to the ufe for which they are intended: when they ferve for navigation, they are fhut with two gates, prefenting an angle towards the ftream; when they are made near the fea, two pair of gates are made, the one to keep the water out and the other in, as occafion requires: in this cafe, the gates towards the fea prefent an angle that way, and the others the contrary way; and the fpace inclofed by thofe gates is called the *chamber*. When fluices are made in the ditches of a fortrefs, to keep up the water in fome parts, inftead of gates, fhutters are made fo as to flide up and down in grooves; and when they are made to raife an inundation, they are then fhut by means of fquare timbers let down in cullifes, fo as to lie clofe and firm.

The word *fluice* is formed of the French *efclufe*, which Menage derives from the Latin *exclufa*, found in the Salic law in the fame fenfe. But this is to be reftrained to the fluices of mills, &c. for as to thofe ferving to raife veffels, they were wholly unknown to the ancients.

SLUR, in *Mufic*, a mark like the arch of a circle, drawn from one note to another, comprehending two or more notes in the fame or different degrees. If the notes are in different degrees, it fignifies that they are all to be fung to one fyllable; for wind inftruments, that they are to be made in one continued breath; and for ftringed inftruments that are ftruck with a bow, as a violin, &c. that they are made with one ftroke. If the notes are in the fame degree, it fignifies that it is all one note, to be made as long as the whole notes fo connected; and this happens moft frequently betwixt the laft note of one line and the firft of the next; which is particularly called *fyncopation*.

SLUYS, a town of Dutch Flanders, oppofite the ifland of Cadfand, with a good harbour, 10 miles north of Bruges, containing 14,000 inhabitants. E. Long. 3. 25. N. Lat. 51. 19.

SMACK, a fmall veffel, commonly rigged as a floop or hoy, ufed in the coafting or fifhing trade, or as a tender in the king's fervice.

SMALAND, or EAST GOTHLAND, a province of Sweden, which makes part of Gothland; and is bounded on the north by Oftrogothia or Eaft Gothland, on the eaft by the Baltic fea, on the fouth by Schonen and Bleckingia, and on the weft by Weftrogothia or Weft Gothland. It is about 112 miles in length, and 62 in breadth. Calmar is the capital town.

SMALKALD, a town of Germany, in Franconia, and in the county of Henneberg: famous for the confederacy entered into by the German Proteftants againft the emperor, commonly called the *league of Smalkald*. The defign of it was to defend their religion and liberties. It is feated on ehe river Werra, 25 miles fouth-weft of Erford, and 50 north-weft of Bamberg. E. Long. 10. 53. N. Lat. 50. 49. It is fubject to the prince of Heffe-Caffel.

SMALLAGE. See APIUM, BOTANY *Index*.

SMALT, a kind of glafs of a dark blue colour, which when levigated appears of a moft beautiful colour; and if it could be made fufficiently fine, would be an excellent fuccedaneum for ultramarine, as not only refifting all kinds of weather, but even the moft violent fires. It is prepared by melting one part of calcined cobalt with two of flint powder, and one of potafh. At the bottoms of the crucibles in which the fmalt is manufactured we generally find a regulus of a whitifh colour inclined to red, and extremely brittle. This is melted afrefh, and when cold feparates into two parts; that at the bottom is the cobaltic regulus, which is employed to make more of the fmalt; the other is bifmuth.

SMARAGDITE, a fpecies of mineral belonging to the magnefian genus. See MINERALOGY, p. 197.

SMARAGDUS, an old name for the emerald. See EMERALD, MINERALOGY, p. 159.

SMEATON, JOHN, an eminent civil engineer, was born the 28th of May 1724, O. S. at Aufthorpe, near Leeds, in a houfe built by his grandfather, and where his family have refided ever fince.

The ftrength of his underftanding and the originality of his genius appeared at an early age; his playthings were not the playthings of children, but the tools which men employ; and he appeared to have greater entertainment in feeing the men in the neighbourhood work, and afking them queftions, than in any thing elfe. One day he was feen (to the diftrefs of his family) on the top of his father's barn, fixing up fomething like a windmill; another time, he attended fome men fixing a pump at a neighbouring village, and obferving them cut off a piece of bored pipe, he was fo lucky as to procure it, and he actually made with it a working pump that raifed water. Thefe anecdotes refer to circumftances that happened while he was in petticoats, and moft likely before he attained his fixth year.

About his 14th and 15th year, he made for himfelf an engine for turning, and made feveral prefents to his friends of boxes in ivory or wood very neatly turned. He forged his iron and fteel, and melted his metal; he had tools of every fort for working in wood, ivory, and metals. He made a lathe, by which he cut a perpetual fcrew in brafs, a thing little known at that day, which was the invention of Mr Henry Hindley of York; with whom Mr Smeaton foon became acquainted, and they fpent many a night at Mr Hindley's houfe till day-light, converfing on thofe fubjects.

Thus had Mr Smeaton, by the ftrength of his genius and indefatigable induftry, acquired, at the age of 18, an extenfive fet of tools, and the art of working in moft of the mechanical trades, without the affiftance of any mafter. A part of every day was generally occupied in forming fome ingenious piece of mechanifm.

Mr Smeaton's father was an attorney, and defirous of bringing him up to the fame profeffion; Mr Smeaton therefore came up to London in 1742, and attended the courts in Weftminfter hall; but finding (as his common expreffion was) that the law did not fuit the bent of his genius, he wrote a ftrong memorial to his father on that fubject; whofe good fenfe from that moment left Mr Smeaton to purfue the bent of his genius in his own way.

In 1751 he began a courfe of experiments to try a machine of his invention to meafure a fhip's way at fea, and alfo made two voyages in company with Dr Knight to try it, and a compafs of his own invention and making, which was made magnetical by Dr Knight's artificial magnets: the fecond voyage was made in the Fortune floop of war, commanded at that time by Captain Alexander Campbell.

In 1753 he was elected member of the Royal Society; the number of papers publifhed in their Tranfactions will fhow the univerfality of his genius and knowledge. In 1759 he was honoured by an unanimous vote with their gold medal for his paper intitled "An Experimental Inquiry concerning the Natural Powers of Water and Wind to turn Mills, and other Machines depending on a Circular Motion."

This paper, he fays, was the refult of experiments made on working models in the years 1752 and 1753, but not communicated to the Society till 1759; before which time he had an opportunity of putting the effect of thefe experiments into real practice, in a variety of cafes, and for various purpofes, fo as to affure the Society he had found them to anfwer.

In December 1755, the Eddyftone lighthoufe was burnt down: Mr Wefton, the chief proprietor, and the others, being defirous of rebuilding it in the moft fubftantial manner, inquired of the earl of Macclesfield (then prefident of the Royal Society) whom he thought the moft proper to rebuild it; his Lordfhip recommended Mr Smeaton.

Mr Smeaton undertook the work, and completed it in the fummer of 1759. Of this Mr Smeaton gives an ample defcription in the volume he publifhed in 1791: that edition has been fold fome time ago, and a fecond is now in the prefs, under the revifal of his much efteemed friend Mr Aubert, F. R. S. and governor of the London affurance corporation.

Though Mr Smeaton completed the building of the Eddyftone lighthoufe in 1759 (a work that does him fo much credit) yet it appears he did not foon get into full bufinefs as a civil engineer; but in 1764, while in Yorkfhire, he offered himfelf a candidate for one of the receivers of the Derwentwater eftate, and on the 31ft of December in that year, he was appointed at a full board of Greenwich hofpital, in a manner highly flattering to himfelf; when two other perfons ftrongly recommended and powerfully fupported were candidates for the employment. In this appointment he was very happy, by the affiftance and abilities of his partner Mr Walton one of the receivers, who taking upon himfelf the management and accounts, left Mr Smeaton leifure and opportunity to exert his abilities on public works, as well as to make many improvements in the mills and in the eftates of Greenwich hofpital. By the year 1775 he had fo much bufinefs as a civil engineer, that he wifhed to refign this appointment; and would have done it then, had not his friend the late Mr Stuart the hofpital furveyor, and Mr Ibbetfon their fecretary, prevailed upon him to continue in the office about two years longer.

Mr Smeaton having now got into full bufinefs as a civil engineer, performed many works of general utility. He made the river Calder navigable; a work that required great fkill and judgement, owing to the very impetuous floods in that river: He planned and attended the execution of the great canal in Scotland for conveying the trade of the country either to the Atlantic or German ocean; and having brought it to the place originally intended, he declined a handfome yearly falary, in order that he might attend to the multiplicity of his other bufinefs.

On the opening of the great arch at London bridge, the excavation around and under the fterlings was fo confiderable, that the bridge was thought to be in great danger of falling. He was then in Yorkfhire, and was fent for by exprefs, and arrived with the utmoft difpatch: "I think (fays Mr Holmes, the author of his life) it was on a Saturday morning, when the apprehenfion of the bridge was fo general that few would pafs over or under it. He applied himfelf immediately to examine it, and to found about the fterlings as minutely as he could; and the committee being called together, adopted his advice, which was to repurchafe the ftones that had been taken from the middle pier, then lying in Moorfields. and to throw them into the river to guard the fterlings." Nothing fhows the apprehenfions concerning the falling of the bridge more than the alacrity with which this advice was purfued; the ftones were repurchafed that day, horfes, carts, and barges were got ready, and they began the work on Sunday morning. Thus Mr Smeaton, in all human probability, faved London bridge from falling, and fecured it till more effectual methods could be taken.

The vaft variety of mills which Mr Smeaton conftructed, fo greatly to the fatisfaction and advantage of the owners, will fhow the great ufe which he made of his experiments in 1752 and 1753; for he never trufted to theory in any cafe where he could have an opportunity to inveftigate it by experiment. He built a fteam engine at Aufthorpe, and made experiments thereon, purpofely to afcertain the power of Newcomen's fteam-engine, which he improved and brought to a greater degree of perfection, both in its conftruction and powers, than it was before.

Mr Smeaton during many years of his life was a frequent attendant on parliament, his opinion being continually called for; and here his ftrength of judgement and perfpicuity of expreffion had its full difplay: it was his conftant cuftom, when applied to, to plan or fupport any meafure, to make himfelf fully acquainted with it, to fee its merits before he would engage in it: by this caution, added to the clearnefs of his defcription and the integrity of his heart, he feldom failed to obtain for the bill which he fupported an act of parliament. No one was heard with more attention, nor had any one ever more confidence placed in his teftimony. In the courts of law he had feveral compliments paid him from the bench by Lord Mansfield and others, for the new light which he threw on difficult fubjects.

About the year 1785 Mr Smeaton's health began to decline; and he then took the refolution to endeavour to avoid all the bufinefs he could, fo that he might have leifure to publifh an account of his inventions and works, which was certainly the firft wifh of his heart; for he has often been heard to fay, that "he thought he could not render fo much fervice to his country as by doing that." He got only his account of the Eddyftone lighthoufe completed, and fome preparations to his intended Treatife on Mills; for he could not refift the folicitations of his friends in various works: and Mr Aubert, whom he greatly loved and refpected, being chofen chairman of Ramfgate harbour, prevailed upon him to accept the place of engineer to that harbour; and to their joint efforts the public is chiefly indebted for the improvements that have been made there within thefe few years, which fully appears in a report that Mr Smeaton gave in to the board of truftees in 1791, which they immediately publifhed.

Mr Smeaton being at Aufthorpe, walking in his garden on the 16th of September 1792, was ftruck with the palfy, and died the 28th of October. "In his illnefs (fays Mr Holmes) I had feveral letters from him, figned with his name, but written and figned by another's pen; the diction of them fhowed that the ftrength his mind had not left him. In one written the 26th of September, after minutely defcribing his health and feelings, he fays, "in confequence of the foregoing, I conclude myfelf nine-tenths dead; and the greateft favour the Almighty can do me (as I think), will be to complete the other part; but as it is likely to be a lingering illnefs, it is only in His power to fay when that is likely to happen."

Mr Smeaton had a warmth of expreffion that might appear to thofe who did not know him well to border on harfhnefs; but thofe more intimately acquainted with him, knew it arofe from the intenfe application of his mind, which was always in the purfuit of truth, or engaged in inveftigating difficult fubjects. He would fometimes break out haftily, when any thing was faid that did not tally with his ideas; and he would not give up any thing he argued for, till his mind was convinced by found reafoning.

In all the focial duties of life he was exemplary; he was a moft affectionate hufband, a good father, a warm, zealous, and fincere friend, always ready to affift thofe he refpected, and often before it was pointed out to him in what way he could ferve them. He was a lover and encourager of merit whatever he found it; and many men are in a great meafure indebted to his affiftance and advice for their prefent fituation. As a companion, he was always entertaining and inftructive; and none could fpend any time in his company without improvement.

SMELL; this word has in moft languages two meanings, fignifying either that fenfation of mind of which we are confcious, in confequence of certain impreffions made on the noftrils, and conveyed to the brain by the olfactory nerves; or that unknown virtue, or quality in bodies, which is the caufe of our fenfations of fmell.

SMELLING is the act by which we perceive fmells, or become fenfible of the prefence of odorous bodies. The fenfations of fmell are excited by certain effluvia, which, in the open air, are always iffuing from the furfaces of moft bodies, and ftriking on the extremities of the olfactory nerves, give them a peculiar fort of impreffion, which is communicated to the brain. The particles which iffue thus from bodies are extremely volatile, and produce fenfation by a degree of contact, which, though infenfible, is ftill more efficient than if it were more grofs and palpable. It is by a fimilar fpecies of infenfible contact that the eyes and ears are affected by external objects; whilft, in the excitation of the fenfations of touch and of tafte, an actual and fenfible contact of the object with the organ is necef-

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sary. The organs of smelling are the nostrils and olfactory nerves; the minute ramifications of the latter being distributed throughout the whole concavity of the former. For a description of these, see ANATOMY.

The effluvia from odorous bodies are constantly floating about in the atmosphere, and must of course be drawn into the nostrils along with the air in inspiration; "so that there is," as Dr Reid observes, "a manifest appearance of design in placing the organ of smell in the inside of that canal, through which the air is continually passing in inspiration and expiration." It has been affirmed by Boerhaave, that the matter in animals, vegetables, fossils, &c. which chiefly affects the sense of smelling, is that attenuated substance, inherent in their oily parts, called *spirits;* because, when this is taken away from the most fragrant bodies, what remains has scarcely any smell at all; but this, he says, if poured on the most inodorous bodies, gives them a fragrancy *. We cannot, however, enter at present upon this inquiry.

* See also *Drummond's Academical Questions*, vol. i. book i. ch 9.

The sense of smell has a close alliance with that of taste; and it seems probable from the proximity in the situation of their organs in all animals, that both are principally intended to guide them in the choice of their food; so that from this close connection, they are better enabled to choose what is good for them, and to reject what would be injurious. This is the opinion of Dr Reid, as it was, in a very early period of the history of philosophy, that of Socrates and of Cicero (A). Dr Reid also remarks, that the sense of smell probably serves the same purpose in the natural state of man; but it is not always a sure guide for this purpose. The organs of smell differ, like those of the other senses, according to the destination of the animals to which they belong; and we know, that this sense is in man much less acute, than it is in many other animals. We see, that in the choice of their food, they are guided by the senses of smell and of taste, except when man has brought them into a sort of unnatural state by domestication. And this circumstance renders it probable, that both these senses were intended to serve the same purpose in the natural state of our species, although less calculated for this end than they are in the brutes, on account of the great superiority of their smelling organs. Besides, since it is probable that man, in the natural state, acts more by instinct than when civilized in society, so also it is reasonable to think, that he may possess some of the senses, (this of smell for instance), in greater acuteness than we do. This indeed, we are assured to be a fact; for we are told, in the *Histoire des Antilles*, that there are negroes who, by the smell alone, can distinguish the footsteps of a Frenchman from those of a negro.

The sense of smell is much more obtuse in man than in some of the lower animals. Dogs we know possess a power of smelling, of which we can scarcely form a conception, and which, it is happy for us we do not possess (B); and birds of prey are said to possess this sense in still greater acuteness. But although this be more perfect, still the sense of smelling in man, who has other means of judging of his food, &c. is such as to fit him for deriving enjoyment from a diversity of scents, particularly those of flowers and perfumes, to which dogs and other animals seem perfectly insensible. It has been said, we are aware, that some animals, the elephant for instance, are capable of this enjoyment (C); but of this fact we cannot help being very doubtful.

There is a very great sympathy between the organs of smell and of taste; for any defect or disease of one is generally attended with some corresponding defect or disease of the other. There is also a greater similarity between the sensations of both these, than between those of any other two senses: and hence it is, that we can sometimes tell the taste of an object from its smell, and *vice versa*. Hence also the reason why we apply the same epithets to the names of both these classes of sensations; as a sweet smell or taste, &c.

It deserves also to be remarked, that both these senses seem subservient to the preservation of the animal existence, rather than to any other purpose. They accordingly constitute an object of the natural history of man, rather than of intellectual or of moral philosophy. The other three senses, on the contrary, seem rather intended for (as they certainly are essential to) our intellectual improvement, and become, of course, a proper object of investigation in the sciences of moral philosophy, or metaphysics.

The advantages derived by man and the other animals from the sense of smelling are not confined to the assistance which it affords them in the choice of their food. Most bodies in nature, when exposed to the open air, are constantly sending forth emanations or effluvia of such extreme minuteness as to be perfectly invisible. These diffuse themselves through the air, and however noxious or salutary, would not be perceived without the sense of smelling, which if not vitiated by unnatural habits, is not only a faithful monitor when danger is at hand, but conveys to us likewise the most exquisite pleasures

(A) "Ut gustus (says a learned physiologist) cibi itineri, sic olfactus ostio viarum, quas aër subire debet, custos præponitur, moniturus ne quid noxii, via quæ semper patet, in corpus admittatur. Porro, ut gustus, sic quoque olfactus ad salutarem cibum invitat, à noxio aut corrupto, putrido imprimis vel rancido, deterret."

"When thou seest the mouth, through which animals take in whatever they desire, always placed near the nose and eyes, thinkest thou not, says Socrates to Aristodemus, that this is the work of a providence." Xenophon's Memorables, book i. chap. 4.

(B) "The excessive eagerness which dogs express on smelling their game, seems to be but little connected with the appetite for food, and wholly independent of any preconceived ideas of the objects of their pursuit being fit for it. Hence several kinds of them will not eat the game which they pursue with such wild impetuosity; and of which the scent seems to animate them to a degree of ecstasy far beyond what the desire of food can produce." Knight on Taste.

(C) There is an animal to which, naturalists say, perfume is so agreeable and so necessary, that nature has provided it with a little bag stored with an exquisite odour. "On pretend, (says Buffon,) que la mangouste ouvre cette poche, pour se refraichir lorsqu' elle a trop chaud."

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pleaſures. The fragrance of a roſe, and of many other flowers, is not only pleaſant, but gives a refreſhing and delightful ſtimulus to the whole ſyſtem, whilſt the odours proceeding from hemlock, or any noxious vegetable, or other ſubſtance, are highly offenſive to our noſtrils. Hence we are naturally led to ſeek the one claſs of ſenſations, and to avoid the other.

In ſome ſpecies of animals the ſenſe of ſmell ſeems to be connected with certain mental ſympathies, as thoſe of hearing and ſight are in all that poſſeſs them in any high degree: for not only their ſexual deſires appear to be excited by means of it, but other inſtinctive paſſions, which, according to the uſual ſyſtem of nature, ſhould be ſtill more remote from its influence. Dogs, although wholly unacquainted with lions, will ſhudder at their roar; and an elephant that has never ſeen a tiger, will in the ſame manner ſhow the ſtrongeſt ſymptoms of horror and affright at the ſmell of it. "The late Lord Clive (ſays an ingenious writer), exhibited a combat between two of theſe animals at Calcutta; but the ſcent of the tiger had ſuch an effect upon the elephant, that nothing could either force or allure him to go along the road, where the cage in which the tiger was incloſed, had paſſed, until a gallon of arack was given him. Upon this, his horror ſuddenly turning into fury, he broke down the paling to get at his enemy, and killed him without difficulty."

If riding along a road, near which a dead horſe, or part of its carcaſs, happens to be lying, we know, that our horſe, although he ſees it not, cannot be made to paſs the place but with difficulty. Where blood has been ſhed, particularly that of their own ſpecies, oxen will aſſemble, and upon ſmelling it, roar and bellow, and ſhow the moſt manifeſt ſigns of horror and diſtreſs. And yet theſe ſymptoms could not ariſe from any aſſociated notions of danger or death, ſince they appear in ſuch as never had any opportunities of acquiring them. They muſt therefore be inſtinctive, like other inſtinctive antipathies and propenſities. But although in their mutual intercourſe, animals make much uſe of the ſenſe of ſmell, ſtill it does not ſeem to be further concerned in exciting their ſexual deſires, than in indicating their object.

Some of thoſe ſplenetic philoſophers, who are ready upon all occaſions to quarrel with the conſtitution of nature, have taken the liberty of condemning their Maker, becauſe it has pleaſed his unfathomable wiſdom to beſtow in ſome inſtances upon the brutes ſenſes and inſtincts more perfect than he has given to man, without reflecting that he has given to man an ample equivalent; for it may be aſked with the poet,

"Is not his reaſon all theſe powers in one?
"Is Heaven unkind to man and man alone?
"Shall he alone, whom rational we call,
"Be pleaſed with nothing if not bleſſed with all."

With reſpect to that unknown peculiarity of bodies, which is the cauſe of our ſenſations of ſmell, the opinions of philoſophers have been very various. Until of late, the doctrine of Deſcartes and Locke on this ſubject was pretty generally received; but, ſince the publication of Doctor Reid's works, his opinion, which we deem the moſt correct and ſatisfactory, has become very popular. We will endeavour to abridge his account of this matter. For this purpoſe, let us ſuppoſe a perſon, who has grown up without the ſenſe of ſmell, to be immediately endowed with the uſe of this organ, and placed near ſome flowers of an exquiſite favour. When he examines what he feels in ſuch a ſituation, he can find no reſemblance between this new ſenſation and any thing with which he is already acquainted. He finds himſelf unable to explain its nature, and cannot aſcribe to it figure, extenſion, or any known property of matter. It is a ſimple affection, or feeling, of mind, and, conſidered abſtractedly, can have no neceſſary connection with the nerves, the noſtrils, or effluvia, or with any thing material whatever. By the nature of his conſtitution he is, however, led to refer this peculiar ſenſation to the noſtrils, as its organ; and when, from experience, and by means of touch, he learns that external objects have the power of exciting this ſenſation, he concludes, that there muſt exiſt in bodies ſome unknown cauſe by which it is excited. In the firſt part of this proceſs he conſiders the feeling, or ſenſation, abſtractedly. As ſuch it exiſts in the mind only; and cannot exiſt there but when the mind is conſcious of it. His conſciouſneſs ſoon enables him to diſtinguiſh different ſorts of ſmells, all of them very diſtinct from one another; but, conformably to the nature of all ſenſation, extremely ſimple. He concludes, that each of theſe muſt have a diſtinct cauſe; and finding, by experience, that this cauſe is an unknown ſomething in bodies, he concludes, that it muſt be a property of matter, and, for want of another, gives it the name of ſmell. When he removes an odorous body from the organ, the ſenſation vaniſhes: when the body is again applied, the ſenſation is excited: and hence it is, that he is led naturally to connect the ſenſation with this unknown peculiarity of bodies by which it is produced. But ſince we ſee, that the ſenſation is, in a great degree, related to other objects beſides its unknown cauſe, to the mind in which it exiſts, for inſtance, and to the organ which is its inſtrument, it may be aſked why it becomes aſſociated in the mind with its cauſe only? The reaſon ſeems pretty obvious. No ſingle ſenſation or claſs of ſenſations, is more connected with the mind, than any others of which it is ſuſceptible. Nor is the connection ſubſiſting between the organ and any of the ſenſations peculiar to it greater than that which ſubſiſts between it and every other ſenſation of which it is the inlet. Hence the connection between the ſmell of an orange and the mind, or between it and the noſtrils, is very general, and cannot, in the former inſtance, diſtinguiſh it from any other ſenſation of whatever kind, nor, in the latter from any other particular ſmell. But the connexion between this ſenſation and the orange is peculiar and permanent; and we accordingly find them always aſſociated in the mind, juſt as we aſſociate the notion of fire with the ſenſation of burning. The relation which a ſenſation of ſmell, or any ſenſation, bears to the mind, to an organ, or to the memory and conception of itſelf, is common to all ſenſations. The relation which any ſenſation bears to its own cauſe, ſuppoſe of the ſenſation of ſmell to a particular virtue or quality of bodies, is common to it with every other ſenſation, when conſidered with reſpect to its peculiar cauſe. And finally, a ſenſation of any kind bears the ſame ſort of relation to the memory and conception of itſelf, that any other feeling or operation of mind bears to the conception and memory of that particular feeling or operation.

Whatever then be the nature of the minute particles of

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of bodies by which our ſenſations of ſmell are excited, we cannot help conſidering their unknown cauſe as a virtue or quality of matter. Like all other modifications of material ſubſtance, it muſt be confeſſed, that this can have no reſemblance to the ſenſations of mind. But we are not, therefore, to conclude with the followers of Des Cartes and Locke, that this ſecondary quality is a mere ſenſation; eſpecially as we can readily conceive it exiſting where it is not ſmelled, or even after ſuppoſing the annihilation of every ſentient being throughout the univerſe. The exiſtence of the ſenſation we know to be momentary and fugitive; but in the exiſtence of its cauſe we can, without difficulty, or inconſiſtency, conceive a permanency independent of mind and of its ſenſations.

The doctrine we have been illuſtrating has of late been called in queſtion by a ſceptical writer, who, it appears to us, has upon this occaſion been entirely deficient in his accuſtomed acuteneſs. Dr Reid's account of this affair ſeems ſo full, ſo clear and convincing, that we are at a loſs to conceive how his meaning can be miſunderſtood; and yet the arguments and objections of the writer to whom we allude, derive all their plauſibility from a miſinterpretation of Dr Reid's meaning, and from a deviation from the eſtabliſhed uſe of language. "An eminent metaphyſician * (ſays this author) has declared that he has not the leaſt difficulty in conceiving the air perfumed with aromatic odours in the deſerts of Arabia; and he has decided, that the man who maintains ſmells to exiſt only in the mind, muſt be mad, or muſt abuſe language and diſgrace philoſophy. There are ſome authors, nevertheleſs, who differ widely on this ſubject from the learned metaphyſician. Is it poſſible for a ſenſation to exiſt where there is no ſentient? The authors to whom I allude think it impoſſible." And ſo, we may tell this learned author, does Dr Reid, if he will take his word for it. Of the ſenſation of ſmell he remarks: "It is indeed impoſſible, that it can be in any body: it is a ſenſation; and a ſenſation can be in a ſentient thing only †." Again, "I can think of the ſmell of a roſe when I do not ſmell it; and it is poſſible that when I think of it there is no roſe any where exiſting; but, when I ſmell it, I am neceſſarily determined to believe that the ſenſation really exiſts. This is common to all ſenſations, that, *as they cannot exiſt but in being perceived*, ſo they cannot be perceived but they muſt exiſt ‡." But, continues this acute metaphyſician, "a ſmell is nothing elſe than a ſenſation. It is a feeling, which may be agreeable or diſagreeable; which may, as ſome think, be excited by various combinations of elements; but which, ſince it is a feeling, cannot be thoſe elements which are ſaid to cauſe it, and cannot exiſt where there is no creature to perceive it. What is to be underſtood, in philoſophical ſtrictneſs, by the perfumes of the deſert? We can excuſe the poet when he makes the ocean ſmile *, the winds dance †, and the flowers reſpire ‡; or even were he to perfume the deſert. But the philoſopher is no ſuch magician, and had better not wander through the regions of fancy in ſearch of ſenſations where there is no ſentient." And is it then true that the word ſmell means only a ſenſation? A ſenſation is no more than an effect; it is a tranſient modification of the mind, which the mind itſelf can never produce. It muſt then have ſome cauſe which is external to the mind. Now, it is to this cauſe, and not to the ſenſation, that the name *ſmell* is moſt frequently applied in all languages; and it is this cauſe which Dr Reid ſuppoſes capable of exiſting in the deſerts of Arabia, where there is no ſentient being to perceive it. But let us hear himſelf: "We have conſidered ſmell as ſignifying a ſenſation, feeling, or impreſſion upon the mind; and in this ſenſe it can only be in a mind or ſentient being: but it is evident that mankind give the name of *ſmell* much more frequently to ſomething which they conceive to be external, and to be a quality of body; they underſtand by it ſomething which does not at all infer a mind, and have not the leaſt difficulty in conceiving the air perfumed with aromatic odours in the deſerts of Arabia, or in ſome uninhabited iſland where the human foot never trod *." "The faculty of ſmelling is ſomething very different from the actual ſenſation of ſmelling; for the faculty may remain when we have no ſenſation. And the mind is no leſs different from the faculty, for it continues the ſame individual being when that faculty is loſt. What is ſmell in the roſe? It is a quality or virtue of the roſe, or of ſomething proceeding from it, which we perceive by the ſenſe of ſmelling; and this is all we know of the matter. But what is ſmelling? It is an act of the mind, but is never imagined to be a quality of the mind. Again, the ſenſation of ſmelling is conceived to infer neceſſarily a mind or ſentient being; but ſmell in the roſe infers no ſuch thing. We ſay, this body ſmells ſweet and that ſtinks; but we do not ſay, this mind ſmells ſweet and that ſtinks; therefore, ſmell in the roſe, and the ſenſation which it cauſes, are not conceived, even by the vulgar, to be things of the ſame kind, although they have the ſame name †."

There are ſome other remarks on Dr Reid's opinions in the work upon which we have been commenting, which we ſhall paſs by; we may, however, notice the author's concluding argument: after mentioning ſome examples, he obſerves, "Now in theſe inſtances we ſee men and animals that muſt have perception of ſmell, if I may be permitted to ſay ſo, altogether different from each other. Is not ſmell ſenſation when the ſpaniel finds ſport in the field for his maſter; when the ſhark purſues through the ocean its expected victim; and when the camel conducts the thirſty wanderer to a fountain of freſh water acroſs the burning ſands of the Arabian deſert? If no animal had the ſenſation of ſmell, there would be no odour; for *aroma* and oils may be thought to be material compoſitions, but are neither agreeable nor diſagreeable feelings." If men and animals differ in their perceptions of ſmell, (and no doubt, difference of organization will cauſe them to do ſo) the concluſion ſhould not be, we think, that ſmell is merely ſenſation, but that there is actually ſomething external which is the cauſe of their ſenſations, and about which they differ. A roſe put to the noſtrils of a man and then to thoſe of a dog, may excite very different ſenſations; but we cannot think that the peculiarity of the roſe, which excites theſe different ſenſations, varies by thus changing the poſition of the roſe. If at table one perſon miſtakes mutton for beef, and another thinks that it is veniſon, the concluſion may be, that it is neither veniſon nor beef; but no man in his ſenſes can conclude that there is no meat at the table. But, "is not ſmell ſenſation when the ſpaniel finds ſport for his maſter in the field?" There is ſenſation no doubt; but we may be permitted to aſk, what would become of the ſpaniel's ſenſation of ſmell and of his maſter's ſport, were there no game in the

* Dr Reid.

† Reid's Inquiry, ch. ii. ſect. 2.

‡ Ibid ch. ii. ſect. 2.

* [illegible]

† Collins.

‡ Thomſon.

* Inquiry, &c. ch. ii. ſect. 2.

† Ibid. ſect. 8.

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the field? What of the shark's sensation of smell and pursuit, were there no victim in the ocean? and what of the camel and the thirsty wanderer, were there no fountain of fresh water in the Arabian deserts? "The *smell of a rose* signifies two things, says Dr Reid; *First*, A sensation which can have no existence but when it is perceived, and can only be in a sentient being or mind. *Secondly*, It signifies some power, quality, or virtue in the rose, or in effluvia proceeding from it, which hath a permanent existence independent of the mind; and which, by the constitution of nature, produces the sensation in us. By the original constitution of our nature we are both led to believe that there is a permanent cause of the sensation, and prompted to seek after it; and experience determines us to place it in the rose. The names of all smells, tastes, sounds, as well as heat and cold, have a like ambiguity in all languages; but it deserves our attention, that these names are but rarely, in common language, used to signify the sensations; for the most part, they signify the external qualities which are indicated by the sensations *." We have been induced thus to discuss this topic at some length, because we regretted to see Dr Reid's opinion and reasoning misrepresented; and we shall now conclude, not as this modern Berkleian does, "that, if no animal had the sensation of smell, there would be no odour;" but, that if there were no odour or external cause of smell, no animal would have this sensation.

* [illegible] 9.

The sense of smell becomes sometimes too acute, either in consequence of some defect or disease of the organ, or from too great a sensibility of the whole nervous system, such as we sometimes observe in fevers, in phrenitis, and in hysterical diseases. It is however more frequently blunted in consequence of affections of the brain and nerves, arising from blows on the head, or from internal causes; or this may happen on account of too great a dryness of the organ, owing to a suppression of the accustomed humours, or to their being conveyed off by some other channel: or it may arise from too great a quantity of tears and of mucus choaking up the nostrils. We have instances of both in cases of common cold, in which, at the beginning of the disease, the nostrils are dry, but as it advances, begin to discharge a great deal of humour, or become obstructed by a thick mucus. Whatever hinders the free entrance of the air into the nostrils or its passage through them, must also injure the sense of smell. It is also sometimes so depraved as to perceive smells when there is no odorous body present, or to perceive smells different from those that are really present. Some of the particles of the odorous effluvia, after having remained for some time in the caverns of the nostrils, issuing forth again and affecting the organ, will sometimes cause this species of false perception, even in the most healthy persons.

The sense of smelling may be diminished or destroyed by diseases; as by the moisture, dryness, inflammation, or suppuration of the olfactory membrane, the compression of the nerves which supply it, or some fault in the brain itself at their origin. A defect, or too great a degree of solidity of the small spongy bones of the upper jaw, the caverns of the forehead, &c. may likewise impair this sense; and it may be also injured by a collection of fetid matter in these caverns, which is continually exhaling from them, and also by immoderate use of snuff. When the nose abounds with moisture, after gentle evacuations, such things as tend to take off irritation and coagulate the thin sharp serum may be applied; as the oil of anise mixed with fine flour, camphor dissolved in oil of almonds, &c. the vapours of amber, frankincense, gum-mastic, and benjamin, may likewise be received into the nose and mouth. For moistening the mucus when it is too dry, some recommend snuff made of the leaves of marjoram, mixed with oil of amber, marjoram, and aniseed; or a sternutatory of calcined white vitriol, twelve grains of which may be mixed with two ounces of marjoram water and filtrated. The steam of vinegar upon hot iron, and received up the nostrils, is also of use for softening the mucus, removing obstructions, &c. If there be an ulcer in the nose, it ought to be dressed with some emollient ointment, to which, if the pain be very great, a little laudanum may be added. If it be a venereal ulcer, 12 grains of corrosive sublimate may be dissolved in a pint and a half of brandy, a table spoonful of which may be taken twice a day. The ulcer ought likewise to be washed with it, and the fumes of cinnabar may be received up the nostrils.

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If there be reason to suspect that the nerves which supply the organs of smelling are inert, or want stimulating, volatile salts, or strong snuffs, and other things which occasion sneezing, may be applied to the nose; the forehead may likewise be anointed with balsam of Peru, to which may be added a little oil of amber.

SMELT. See SALMO, ICHTHYOLOGY *Index*.

SMELTING, in *Metallurgy*, the fusion or melting of the ores of metals, in order to separate the metalline part from the earthy, stony, and other parts. See *ORES, Reduction of*.

SMEW. See MERGUS, ORNITHOLOGY *Index*.

SMILAX, ROUGH BINDWEED, a genus of plants belonging to the class of *diœcia* and order of *hexandria*; and in the natural system ranging under the 11th order, *Sarmentaceæ*. See BOTANY, and MATERIA MEDICA *Index*.

SMITH, SIR THOMAS, was born at Walden in Essex in 1512. At 14 he was sent to Queen's college Cambridge, where he distinguished himself so much, that he was made Henry VIII.'s scholar together with John Cheke. He was chosen a fellow of his college in 1531, and appointed two years after to read the public Greek lecture. The common mode of reading Greek at that time was very faulty; the same sound being given to the letters and diphthongs, ι, η, υ, ει, οι, υι. Mr Smith and Mr Cheke had been for some time sensible that this pronunciation was wrong: and after a good deal of consultation and research, they agreed to introduce that mode of reading which prevails at present. Mr Smith was lecturing on *Aristotle de Republica* in Greek. At first he dropped a word or two at intervals in the new pronunciation, and sometimes he would stop as if he had committed a mistake and correct himself. No notice was taken of this for two or three days; but as he repeated more frequently, his audience began to wonder at the unusual sounds, and at last some of his friends mentioned to him what they had remarked. He owned that something was in agitation, but that it was not yet sufficiently digested to be made public. They entreated him earnestly to discover his project: he did so; and in a short time great numbers resorted to him for information. The new pronunciation

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was adopted with enthuſiaſm, and ſoon became univerſal at Cambridge. It was afterwards oppoſed by Biſhop Gardiner the chancellor; but its ſuperiority to the old mode was ſo viſible, that in a few years it ſpread over all England.

In 1539 he travelled into foreign countries, and ſtudied for ſome time in the univerſities of France and Italy. On his return he was made regius profeſſor of civil law at Cambridge. About this time he publiſhed a treatiſe on the mode of pronouncing Engliſh. He was uſeful likewiſe in promoting the reformation. Having gone into the family of the duke of Somerſet, the protector during the minority of Edward VI. he was employed by that nobleman in public affairs; and in 1548 was made ſecretary of ſtate, and received the honour of knighthood. While that nobleman continued in office, he was ſent ambaſſador, firſt to Bruſſels and afterwards to France.

Upon Mary's acceſſion he loſt all his places, but was fortunate enough to preſerve the friendſhip of Gardiner and Bonner. He was exempted from perſecution, and was allowed, probably by their influence, a penſion of 100 l. During Elizabeth's reign he was employed in public affairs, and was ſent three times by that princeſs as her ambaſſador to France. He died in 1577. His abilities were excellent, and his attainments uncommonly great: He was a philoſopher, a phyſician, a chemiſt, mathematician, linguiſt, hiſtorian, and architect. He wrote, 1. A treatiſe called the *Engliſh Commonwealth*. 2. A letter *De Recta et Emendata Linguæ Græcæ Pronunciatione*. 3. *De Moribus Turcarum*. 4. *De Druidum Moribus*.

SMITH, *Edmund*, an Engliſh poet, the only ſon of Mr Neale an eminent merchant, by a daughter of Baron Lechmere, was born in 1668. By his father's death he was left young to the care of Mr Smith, who had married his father's ſiſter, and who treated him with ſo much tenderneſs, that at the death of his generous guardian he aſſumed his name. His writings are not many, and thoſe are ſcattered about in miſcellanies and collections: his celebrated tragedy of Phædra and Hippolitus was acted in 1707; and being introduced at a time when the Italian opera ſo much engroſſed the polite world, gave Mr Addiſon, who wrote the prologue, an opportunity to rally the vitiated taſte of the public. However, notwithſtanding the eſteem it has always been held in, it is perhaps rather to be conſidered as a fine poem than as a good play. This tragedy, with a Poem to the memory of Mr John Philips, three or four Odes, with a Latin oration ſpoken at Oxford *in laudem Thomæ Bodleii*, were publiſhed as his works by his friend Mr Oldiſworth. Mr Smith died in 1710, ſunk into indolence and intemperance by poverty and diſappointments; the hard fate of many a man of genius.

SMITH, *John*, an excellent mezzotinter, flouriſhed about 1700; but neither the time of his birth nor death is accurately known. He united ſoftneſs with ſtrength, and finiſhed with freedom. He ſerved his time with one Tillet a painter in Moorfields; and as ſoon as he became his own maſter, learned from Becket the ſecret of mezzotinto, and being farther inſtructed by Van der Vaart, was taken to work in Sir Godfrey Kneller's houſe; and as he was to be the publiſher of that maſter's works, doubtleſs received conſiderable hints from him, which he amply repaid. "To poſterity perhaps his prints (ſays Mr Walpole) will carry an idea of ſomething burleſque; perukes of an enormous length flowing over ſuits of armour, compoſe wonderful habits. It is equally ſtrange that faſhion could introduce the one, and eſtabliſh the practice of repreſenting the other when it was out of faſhion. Smith excelled in exhibiting both, as he found them in the portraits of Kneller, who was leſs happy in what he ſubſtituted to armour. In the Kit-cat club he has poured full bottoms chiefly over night gowns. If thoſe ſtreams of hair were *incommode* in a battle, I know nothing (he adds) they were adapted to that can be done in a night-gown. Smith compoſed two large volumes, with proofs of his own plates, for which he aſked 50l. His fineſt works are Duke Schomberg on horſeback; that duke's ſon and ſucceſſor Maynhard: the earls of Pembroke, Dorſet, and Albemarle; three plates with two figures in each, of young perſons or children, in which he ſhone; William Cowper; Gibbons and his wife; Queen Anne; the duke of Glouceſter, a whole length, with a flower-pot; a very curious one of Queen Mary, in a high head, fan, and gloves; the earl of Godolphin; the ducheſs of Ormond, a whole length, with a black; Sir George Rooke, &c. There is a print by him of James II. with an anchor, but no inſcription; which not being finiſhed when the king went away, is ſo ſcarce that it is ſometimes ſold for above a guinea. Smith alſo performed many hiſtoric pieces; as the loves of the gods, from Titian, at Blenheim, in ten plates; Venus ſtanding in a ſhell, from a picture by Corregio, and many more, of which perhaps the moſt delicate is the holy family with angels, after Carlo Maratti." *Walpole's Catalogue of Engravers.*

SMITH, *Dr Adam*, the celebrated author of the Inquiry into the Nature and Cauſes of the Wealth of Nations, was the only ſon of Adam Smith comptroller of the cuſtoms at Kirkaldy, and of Margaret Douglas daughter of Mr Douglas of Strathenry. He was born at Kirkaldy on the 5th June 1723, a few months after the death of his father. His conſtitution during his infancy was infirm and ſickly, and required all the care of his ſurviving parent. When only three years old he was carried by his mother to Strathenry on a viſit to his uncle Mr Douglas; and happening one day to be amuſing himſelf alone at the door of the houſe, he was ſtolen by a party of thoſe vagrants who in Scotland are called *tinkers*. Luckily he was miſſed immediately, and the vagrants purſued and overtaken in Leſlie wood; and thus Dr Smith was preſerved to extend the bounds of ſcience, and reform the commercial policy of Europe. *Philoſophical Tranſactions of the Royal Society of Edinburgh, vol. iii.*

He received the rudiments of his education in the ſchool of Kirkaldy under David Miller, a teacher of conſiderable eminence, and whoſe name deſerves to be recorded on account of the great number of eminent men which that ſeminary produced while under his direction. Dr Smith, even while at ſchool, attracted notice by his paſſionate attachment to books, and by the extraordinary powers of his memory; while his friendly and generous diſpoſition gained and ſecured the affection of his ſchoolfellows. Even then he was remarkable for thoſe habits which remained with him through life, of ſpeaking to himſelf when alone and of abſence in company. He was ſent in 1737 to the univerſity of Glaſgow, where he remained till 1740, when he went

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to Balliol college Oxford, as an exhibitioner on Snell's foundation. His favourite pursuits while at the university were mathematics and natural philosophy. After his removal to England he frequently employed himself in translating, particularly from the French, with a view to the improvement of his own style: a practice which he often recommended to all who wished to cultivate the art of composition. It was probably then also that he applied himself with the greatest care to the study of languages, of which, both ancient and modern, his knowledge was uncommonly extensive and accurate.

After seven years residence at Oxford he returned to Kirkaldy, and lived two years with his mother without any fixed plan for his future life. He had been designed for the church of England; but disliking the ecclesiastical profession, he resolved to abandon it altogether, and to limit his ambition to the prospect of obtaining some of those preferments to which literary attainments lead in Scotland. In 1748 he fixed his residence in Edinburgh, and for three years read a course of lectures on rhetoric and belles lettres under the patronage of Lord Kames. In 1751 he was elected professor of logic in the university of Glasgow, and the year following was removed to the professorship of moral philosophy, vacant by the death of Mr Thomas Cragie, the immediate successor of Dr Hutcheson. In this situation he remained 13 years, a period he used frequently to look back to as the most useful part of his life. His lectures on moral philosophy were divided into four parts: The first contained natural theology; in which he considered the proofs of the being and attributes of God, and those truths on which religion is founded: the second comprehended ethics, strictly so called, and consisted chiefly of those doctrines which he afterwards published in his theory of moral sentiments: in the third part he treated more at length of that part of morality called *justice;* and which, being susceptible of precise and accurate rules, is for that reason capable of a full and accurate explanation: in the last part of his lectures he examined those political regulations which are founded, not upon the principle of justice, but of expediency; and which are calculated to increase the riches, the power, and the prosperity of a state. Under this view he considered the political institutions relating to commerce, to finances, to ecclesiastical and military governments: this contained the substance of his *Wealth of Nations*. In delivering his lectures he trusted almost entirely to extemporary elocution: his manner was plain and unaffected, and he never failed to interest his hearers. His reputation soon rose very high, and many students resorted to the university merely upon his account.

When his acquaintance with Mr Hume first commenced is uncertain; but it had ripened into friendship before the year 1752.

In 1759 he published his Theory of Moral Sentiments; a work which deservedly extended his reputation: for, though several of its conclusions be ill-founded, it must be allowed by all to be a singular effort of invention, ingenuity, and subtilty. Besides, it contains a great mixture of important truth; and, though the author has sometimes been misled, he has had the merit of directing the attention of philosophers to a view of human nature, which had formerly in a great measure escaped their notice. It abounds everywhere with the purest and most elevated maxims concerning the practical conduct of life; and when the subject of his work leads him to address the imagination and the heart, the variety and felicity of his illustrations, the richness and fluency of his eloquence, and the skill with which he wins the attention and commands the passions of his readers, leave him among our British moralists without a rival.

Towards the end of 1763 Dr Smith received an invitation from Mr Charles Townsend to accompany the duke of Buccleugh on his travels; and the liberal terms in which this proposal was made induced him to resign his office at Glasgow. He joined the duke of Buccleugh at London early in the year 1764, and set out with him for the continent in the month of March following. After a stay of about ten days at Paris, they proceeded to Thoulouse, where they fixed their residence for about 18 months; thence they went by a pretty extensive route through the south of France to Geneva, where they passed two months. About Christmas 1765 they returned to Paris, and remained there till October following. The society in which Dr Smith passed these ten months may be conceived in consequence of the recommendation of Mr Hume. Turgot, Quesnai, Necker, d'Alembert, Helvetius, Marmontel, Madame Riccoboni, were among the number of his acquaintances; and some of them he continued ever after to reckon among the number of his friends. In October 1766 the duke of Buccleugh returned to England.

Dr Smith spent the next ten years of his life with his mother at Kirkaldy, occupied habitually in intense study, but unbending his mind at times in the company of some of his old schoolfellows, who still continued to reside near the place of their birth. In 1776 he published his *Inquiry into the Nature and Causes of the Wealth of Nations;* a book so universally known, that any panegyric on it would be useless. The variety, importance, and (may we not add) novelty, of the information which it contains; the skill and comprehensiveness of mind displayed in the arrangement; the admirable illustrations with which it abounds; together with a plainness and perspicuity which makes it intelligible to all—render it unquestionably the most perfect work which has yet appeared on the general principles of any branch of legislation.

He spent the next two years of his life in London, where he enjoyed the society of some of the most eminent men of the age: but he removed to Edinburgh in 1778, in consequence of having been appointed, at the request of the duke of Buccleugh, one of the commissioners of the customs in Scotland. Here he spent the last twelve years of his life in an affluence which was more than equal to all his wants. But his studies seemed entirely suspended till the infirmities of old age reminded him, when it was too late, of what he yet owed to the public and to his own fame. The principal materials of the works which he had announced had long ago been collected, and little probably was wanting but a few years of health and retirement to complete them. The death of his mother, who had accompanied him to Edinburgh in 1784, together with that of his cousin Miss Douglas in 1788, contributed to frustrate these projects. They had been the objects of his affection for

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for more than 60 years, and in their ſocieties he had enjoyed from his infancy all that he ever knew of the endearments of a family. He was now alone and helpleſs; and though he bore his loſs with equanimity, and regained apparently his former cheerfulneſs, yet his health and ſtrength gradually declined till the period of his death, which happened in July 1790. Some days before his death he ordered all his papers to be burnt except a few eſſays, which have ſince been publiſhed.

Of the originality and comprehenſiveneſs of his views; the extent, the variety, and the correctneſs of his information; the inexhauſtible fertility of his invention—he has left behind him laſting monuments. To his private worth, the moſt certain of all teſtimonies may be found in that confidence, reſpect, and attachment, which followed him through all the various relations of life. He was habitually abſent in converſation, and was apt when he ſpoke to deliver his ideas in the form of a lecture. He was rarely known to ſtart a new topic himſelf, or to appear unprepared upon thoſe topics that were introduced by others. In his external form and appearance there was nothing uncommon. When perfectly at eaſe, and when warmed with converſation, his geſtures were animated and not ungraceful; and in the ſociety of thoſe he loved, his features were often brightened by a ſmile of inexpreſſible benignity. In the company of ſtrangers, his tendency to abſence, and perhaps ſtill more his conſciouſneſs of that tendency, rendered his manners ſomewhat embarraſſed: an effect which was probably not a little heightened by thoſe ſpeculative ideas of propriety which his recluſe habits tended at once to perfect in his conception, and to diminiſh his power of realizing.

SMITHIA, a genus of plants belonging to the *diadelphia* claſs; and in the natural method ranking under the 32d order, *Papilionaceæ*. See BOTANY *Index*.

SMITHERY, a ſmith's ſhop; alſo the art of a ſmith, by which iron is wrought into any ſhape by means of fire, hammering, filing, &c.

SMITING-LINE, in a ſhip, is a ſmall rope faſtened to the mizen-yard arm, below at the deck, and is always furled up with the mizen-ſail, even to the upper end of the yard, and thence it comes down to the poop. Its uſe is to looſe the mizen-ſail without ſtriking down the yard, which is eaſily done, becauſe the mizen-ſail is furled up only with rope-yarns; and therefore when this rope is pulled hard, it breaks all the rope-yarns, and ſo the ſail falls down of itſelf. The ſailor's phraſe is, *ſmite the mizen* (whence this rope takes its name), that is, hale by this rope that the ſail may fall down.

SMOKE, a denſe elaſtic vapour, ariſing from burning bodies. As this vapour is extremely diſagreeable to the ſenſes, and often prejudicial to the health, mankind have fallen upon ſeveral contrivances to enjoy the benefit of fire, without being annoyed by ſmoke. The moſt univerſal of theſe contrivances is a tube leading from the chamber in which the fire is kindled to the top of the building, through which the ſmoke aſcends, and is diſperſed into the atmoſphere. Theſe tubes are called *chimneys*; which, when conſtructed in a proper manner, carry off the ſmoke entirely; but, when improperly conſtructed, they carry off the ſmoke imperfectly, to the great annoyance of the inhabitants. As our maſons at preſent ſeem to have a very imperfect knowledge of the manner in which chimneys ought to be built, we can hardly perform a more acceptable ſervice to the public than to point out the manner in which they ought to be conſtructed, ſo as to carry off the ſmoke entirely; as well as to explain the cauſes from which the defects ſo often complained of generally proceed, and the method of removing them.

Smoke.

Tranſactions of the American Philoſophical Society.

Thoſe who would be acquainted with this ſubject, ſhould begin by conſidering on what principle ſmoke aſcends in any chimney. At firſt many are apt to think that ſmoke is in its nature, and of itſelf, ſpecifically lighter than air, and riſes in it for the ſame reaſon that cork riſes in water. Theſe ſee no cauſe why ſmoke ſhould not riſe in the chimney though the room be ever ſo cloſe. Others think there is a power in chimneys to *draw* up the ſmoke, and that there are different forms of chimneys which afford more or leſs of this power. Theſe amuſe themſelves with ſearching for the beſt form. The equal dimenſions of a funnel in its whole length is not thought artificial enough, and it is made, for fancied reaſons, ſometimes tapering and narrowing from below upwards, and ſometimes the contrary, &c. &c. A ſimple experiment or two may ſerve to give more correct ideas. Having lighted a pipe of tobacco, plunge the ſtem to the bottom of a decanter half filled with cold water; then putting a rag over the bowl, blow through it, and make the ſmoke deſcend in the ſtem of the pipe, from the end of which it will riſe in bubbles through the water; and being thus cooled, will not afterwards riſe to go out through the neck of the decanter, but remain ſpreading itſelf and reſting on the ſurface of the water. This ſhows that ſmoke is really heavier than air, and that it is carried upwards only when attached to or acted upon by air that is heated, and thereby rarefied and rendered ſpecifically lighter than the air in its neighbourhood.

Smoke being rarely ſeen but in company with heated air, and its upward motion being viſible, though that of the rarefied air that drives it is not ſo, has naturally given riſe to the error. It is now well known that air is a fluid which has weight as well as others, though about 800 times lighter than water; that heat makes the particles of air recede from each other, and take up more ſpace, ſo that the ſame weight of air heated will have more bulk than equal weights of cold air which may ſurround it, and in that caſe muſt riſe, being forced upwards by ſuch colder and heavier air, which preſſes to get under it and take its place. That air is ſo rarefied or expanded by heat, may be proved to their comprehenſion by a lank blown bladder, which laid before a fire, will ſoon ſwell, grow tight, and burſt.

Another experiment may be to take a glaſs tube about an inch in diameter, and 12 inches long, open at both ends, and fixed upright on legs ſo that it need not be handled, for the hands might warm it. At the end of a quill faſten five or ſix inches of the fineſt light filament of ſilk, ſo that it may be held either above the upper end of the tube or under the lower end, your warm hand being at a diſtance by the length of the quill. If there were any motion of air through the tube, it would manifeſt itſelf by its effect on the ſilk; but if the tube and the air in it are of the ſame temperature with the ſurrounding air, there will be no ſuch motion, whatever may be the form of the tube, whether crooked or ſtraight, narrow below and widening up-

Plate cccclxxvii.

wards, or the contrary, the air in it will be quiefcent. Warm the tube, and you will find as long as it continues warm, a conftant current of air entering below and paffing up through it till difcharged at the top; becaufe the warmth of the tube being communicated to the air it contains, rarefies that air, and makes it lighter than the air without; which therefore preffes in below, forces it upwards, follows and takes its place, and is rarefied in its turn. And, without warming the tube, if you hold under it a knob of hot iron, the air thereby heated will rife and fill the tube, going out at its top; and this motion in the tube will continue as long as the knob remains hot, becaufe the air entering the tube below, is heated and rarefied by paffing near and over that knob.

That this motion is produced merely by the difference of fpecific gravity between the fluid within and that without the tube, and not by any fancied form of the tube itfelf, may appear by plunging it into water contained in a glafs jar a foot deep, through which fuch motion might be feen. The water within and without the tube being of the fame fpecific gravity, balance each other, and both remain at reft. But take out the tube, ftop its bottom with a finger, and fill it with olive oil, which is lighter than water; then ftopping the top, place it as before, its lower end under water, its top a very little above. As long as you keep the bottom ftopped the fluids remain at reft; but the moment it is unftopt, the heavier enters below, forces up the lighter, and takes its place: and the motion then ceafes, merely becaufe the new fluid cannot be fucceffively made lighter, as air may be by a warm tube.

In fact, no form of the funnel of a chimney has any fhare in its operation or effect refpecting fmoke except its height. The longer the funnel, if erect, the greater its force when filled with heated and rarefied air to draw in below and drive up the fmoke, if one may, in compliance with cuftom, ufe the expreffion *draw*, when in fact it is the fuperior weight of the furrounding atmofphere that preffed to enter the funnel below, and fo drives up before it the fmoke and warm air it meets with in its paffage.

What is it then which makes a fmoky chimney, that is, a chimney which, inftead of conveying up all the fmoke, difcharges a part of it into the room, offending the eyes and damaging the furniture?

The caufes of this effect may be reduced to *nine*, differing from each other, and therefore requiring different remedies.

1. *Smoky chimneys in a new houfe are fuch frequently from mere want of air.* The workmanfhip of the rooms being all good, and juft out of the workman's hands, the joints of the boards of the flooring, and of the pannels of wainfcotting, are all true and tight; the more fo as the walls, perhaps not yet thoroughly dry, preferve a dampnefs in the air of the room which keeps the woodwork fwelled and clofe. The doors and the fafhes too, being worked with truth, fhut with exactnefs, fo that the room is as tight as a fnuff-box, no paffage being left open for air to enter except the key-hole, and even that is fometimes covered by a little dropping fhutter. Now if fmoke cannot rife but as connected with rarefied air, and a column of fuch air, fuppofe it filling the funnel, cannot rife unlefs other air be admitted to fupply its place; and if therefore no current of air enter the opening of the chimney—there is nothing to prevent the fmoke from coming out into the room. If the motion upwards of the air in a chimney that is freely fupplied be obferved by the rifing of the fmoke or a feather in it, and it be confidered that in the time fuch feather takes in rifing from the fire to the top of the chimney, a column of air equal to the content of the funnel muft be difcharged, and an equal quantity fupplied from the room below, it will appear abfolutely impoffible that this operation fhould go on if the tight room is kept fhut; for were there any force capable of drawing conftantly fo much air out of it, it muft foon be exhaufted like the receiver of an air-pump, and no animal could live in it. Thofe therefore who ftop every crevice in a room to prevent the admiffion of frefh air, and yet would have their chimney carry up the fmoke, require inconfiftencies, and expect impoffibilities. Yet under this fituation it is not uncommon to fee the owner of a new houfe in defpair, and ready to fell it for much lefs than it coft; conceiving it uninhabitable becaufe not a chimney in any one of its rooms will carry off the fmoke unlefs a door or window be left open. Much expence has alfo been made to alter and amend new chimneys which had really no fault: in one houfe particularly which Dr Franklin knew that belonged to a nobleman in Weftminfter, that expence amounted to no lefs than 300l. after his houfe had been, as he thought, finifhed and all charges paid. And after all, feveral of the alterations were ineffectual, for want of underftanding the true principles.

Remedies. When you find on trial that opening the door or a window enables the chimney to carry up all the fmoke, you may be fure that want of air from without was the caufe of its fmoking. "I fay from *without* (adds Dr Franklin), to guard you againft a common miftake of thofe who may tell you the room is large, contains abundance of air fufficient to fupply any chimney, and therefore it cannot be that the chimney wants air. Thefe reafoners are ignorant that the largenefs of a room, if tight, is in this cafe of fmall importance, fince it cannot part with a chimneyfull of its air without occafioning fo much vacuum; which it requires a great force to effect, and could not be borne if effected."

It appearing plainly then, that fome of the outward air muft be admitted, the queftion will be, how much is abfolutely neceffary? for you would avoid admitting more, as being contrary to one of your intentions in having a fire, viz. that of warming your room. To difcover this quantity, fhut the door gradually while a middling fire is burning, till you find that before it is quite fhut the fmoke begins to come out into the room; then open it a little till you perceive the fmoke comes out no longer. There hold the door, and obferve the width of the open crevice between the edge of the door and the rabbet it fhould fhut into. Suppofe the diftance to be half an inch, and the door eight feet high; you find thence that your room requires an entrance for air equal in area to 96 half inches, or 48 fquare inches, or a paffage of 6 inches by 8. This, however, is a large fuppofition; there being few chimneys that, having a moderate opening and a tolerable height of funnel, will not be fatisfied with fuch a crevice of a quarter of an inch: Dr Franklin found a fquare of 6 by 6, or 36 fquare inches, to be pretty good medium that

Smoke.

that will ferve for moft chimneys. High funnels with fmall and low openings may indeed be fupplied through a lefs fpace; becaufe, for reafons that will appear hereafter, the force of levity, if one may fo fpeak, being greater in fuch funnels, the cool air enters the room with greater velocity, and confequently more enters in the fame time. This, however, has its limits; for experience fhows, that no increafed velocity fo occafioned has made the admiffion of air through the key-hole equal in quantity to that through an open door, though through the door the current moves flowly, and through the key-hole with great rapidity.

It remains then to be confidered, how and where this neceffary quantity of air from without is to be admitted fo as to be leaft inconvenient: for if at the door, left fo much open, the air thence proceeds directly to the chimney, and in its way comes cold to your back and heels as you fit before your fire. If you keep the door fhut, and raife a little the fafh of your window, you feel the fame inconvenience. Various have been the contrivances to avoid this; fuch as bringing in frefh air through pipes in the jams of the chimney, which pointing upwards fhould blow the fmoke up the funnel; opening paffages into the funnel above, to let in air for the fame purpofe. But thefe produce an effect contrary to that intended: for as it is the conftant current of air paffing from the room through the opening of the chimney into the funnel which prevents the fmoke from coming out into the room, if you fupply the funnel by other means or in other ways with the air which it wants, and efpecially if that air be cold, you diminifh the force of that current, and the fmoke in its efforts to enter the room finds lefs refiftance.

The wanted air muft then indifpenfably be admitted into the room, to fupply what goes off through the opening of the chimney. M. Gauger, a very ingenious and intelligent French writer on the fubject, propofes with judgement to admit it above the opening of the chimney; and to prevent inconvenience from its coldnefs, he directs that it may be fo made, that it fhall pafs in its entrance through winding cavities made behind the iron back and fides of the fire-place, and under the iron hearth-plate; in which cavities it will be warmed, and even heated, fo as to contribute much, inftead of cooling, to the warming of the room. This invention is excellent in itfelf, and may be ufed with advantage in building new houfes; becaufe the chimneys may then be fo difpofed as to admit conveniently the cold air to enter fuch paffages: but in houfes built without fuch views, the chimneys are often fo fituated as not to afford that convenience without great and expenfive alterations. Eafy and cheap methods, though not quite fo perfect in themfelves, are of more general utility; and fuch are the following.

In all rooms where there is a fire, the body of air warmed and rarefied before the chimney is continually changing place, and making room for other air that is to be warmed in its turn. Part of it enters and goes up the chimney, and the reft rifes and takes place near the ceiling. If the room be lofty, that warm air remains above our heads as long as it continues warm, and we are little benefited by it, becaufe it does not defcend till it is cooler. Few can imagine the difference of climate between the upper and lower parts of fuch a room, who have not tried it by the thermometer, or by going up a ladder till their heads are near the ceiling. It is then among this warm air that the wanted quantity of outward air is beft admitted, with which being mixed, its coldnefs is abated, and its inconvenience diminifhed fo as to become fcarce obfervable. This may be eafily done by drawing down about an inch the upper fafh of a window; or, if not moveable, by cutting fuch a crevice through its frame; in both which cafes it will be well to place a thin fhelf of the length to conceal the opening, and floping upwards, to direct the entering air horizontally along and under the ceiling. In fome houfes the air may be admitted by fuch a crevice made in the wainfcot, cornice, or plaftering, near the ceiling and over the opening of the chimney. This, if practicable, is to be chofen, becaufe the entering cold air will there meet with the warmeft rifing air from before the fire, and be fooneft tempered by the mixture. The fame kind of fhelf fhould alfo be placed here. Another way, and not a very difficult one, is to take out an upper pane of glafs in one of your fafhes, fet it in a tin frame, giving it two fpringing angular fides, and then replacing it, with hinges below on which it may be turned to open more or lefs above. It will then have the appearance of an internal fky-light. By drawing this pane in, more or lefs, you may admit what air you find neceffary. Its pofition will naturally throw that air up and along the ceiling. This is what is called in France a *Was ift das?* As this is a German queftion, the invention is probably of that nation, and takes its name from the frequent afking of that queftion when it firft appeared. In England fome have of late years cut a round hole about five inches diameter in a pane of the fafh and placed againft it a circular plate of tin hung on an axis, and cut into vanes; which, being feparately bent a little obliquely, are acted upon by the entering air, fo as to force the plate continually round like the vanes of a windmill. This admits the outward air, and by the continual whirling of the vanes, does in fome degree difperfe it. The noife only is a little inconvenient.

Fig. 2.

2. A fecond caufe of the fmoking of chimneys is, *their openings in the room being too large*; that is, too wide, too high, or both. Architects in general have no other ideas of proportion in the opening of a chimney than what relate to fymmetry and beauty refpecting the dimenfions of the room; while its true proportion refpecting its function and utility depends on quite other principles; and they might as properly proportion the ftep in a ftaircafe to the height of the ftory, inftead of the natural elevation of men's legs in mounting. The proportion then to be regarded, is what relates to the height of the funnel. For as the funnels in the different ftories of a houfe are neceffarily of different heights or lengths, that from the loweft floor being the higheft or longeft, and thofe of the other floors fhorter and fhorter, till we come to thofe in the garrets, which are of courfe the fhorteft; and the force of draft being, as already faid, in proportion to the height of funnel filled with rarefied air, and a current of air from the room into the chimney, fufficient to fill the opening, being neceffary to oppofe and prevent the fmoke from coming out into the room; it follows, that the openings of the longeft funnels may be larger, and that thofe of the fhorter funnels fhould be fmaller. For if there be a large opening to a chimney that does not draw ftrongly, the funnel may

may happen to be furnifhed with the air which it demands by a partial current entering on one fide of the opening, and leaving the other fide free of any oppofing current, may permit the fmoke to iffue there into the room. Much too of the force of draft in a funnel depends on the degree of rarefaction in the air it contains, and that depends on the nearnefs to the fire of its paffage in entering the funnel. If it can enter far from the fire on each fide, or far above the fire, in a wide or high opening, it receives little heat in paffing by the fire, and the contents of the funnel are by thofe means lefs different in levity from the furrounding atmofphere, and its force in drawing confequently weaker. Hence if too large an opening be given to chimneys in upper rooms, thofe rooms will be fmoky: On the other hand, if too fmall openings be given to chimneys in the lower rooms, the entering air operating too directly and violently on the fire, and afterwards ftrengthening the draft as it afcends the funnel, will confume the fuel too rapidly.

Remedy. As different circumftances frequently mix themfelves in thefe matters, it is difficult to give precife dimenfions for the openings of all chimneys. Our fathers made them generally much too large: we have leffened them; but they are often ftill of greater dimenfions than they fhould be, the human eye not being eafily reconciled to fudden and great changes. If you fufpect that your chimney fmokes from the too great dimenfion of its opening, contract it by placing moveable boards fo as to lower and narrow it gradually till you find the fmoke no longer iffues into the room. The proportion fo found will be that which is proper for that chimney, and you may employ the bricklayer or mafon to reduce it accordingly. However, as in building new houfes fomething muft be fometimes hazarded, Dr Franklin propofes to make the openings in the lower rooms about 30 inches fquare and 18 deep, and thofe in the upper only 18 inches fquare and not quite fo deep; the intermediate ones diminifhing in proportion as the height of the funnel is diminifhed. In the larger openings, billets of two feet long, or half the common length of cordwood, may be burnt conveniently; and for the fmaller, fuch wood may be fawed into thirds. Where coals are the fuel, the grates will be proportioned to the openings. The fame depth is nearly neceffary to all, the funnels being all made of a fize proper to admit a chimney-fweeper. If in large and elegant rooms cuftom or fancy fhould require the appearance of a larger chimney, it may be formed of expenfive marginal decorations, in marble, &c. But in time perhaps, that which is fitteft in the nature of things may come to be thought handfomeft.

3. Another caufe of fmoky chimneys is *too fhort a funnel.* This happens neceffarily in fome cafes, as where a chimney is required in a low building; for, if the funnel be raifed high above the roof, in order to ftrengthen its draft, it is then in danger of being blown down, and crufhing the roof in its fall.

Remedies. Contract the opening of the chimney, fo as to oblige all the entering air to pafs through or very near the fire; whereby it will be more heated and rarefied, the funnel itfelf be more warmed, and its contents have more of what may be called the force of levity, fo as to rife ftrongly and maintain a good draft at the opening.

Or you may in fome cafes, to advantage, build additional ftories over the low building, which will fupport a high funnel.

If the low building be ufed as a kitchen, and a contraction of the opening therefore inconvenient, a large one being neceffary, at leaft when there are great dinners, for the free management of fo many cooking utenfils; in fuch cafe the beft expedient perhaps would be to build two more funnels joining to the firft, and having three moderate openings, one to each funnel, inftead of one large one. When there is occafion to ufe but one, the other two may be kept fhut by fliding plates, hereafter to be defcribed; and two or all of them may be ufed together when wanted. This will indeed be an expence, but not an ufelefs one, fince your cooks will work with more comfort, fee better than in a fmoky kitchen what they are about, your victuals will be cleaner dreffed and not tafte of fmoke, as is often the cafe; and to render the effect more certain, a ftack of three funnels may be fafely built higher above the roof than a fingle funnel.

The cafe of too fhort a funnel is more general than would be imagined, and often found where one would not expect it. For it is not uncommon, in ill-contrived buildings, inftead of having a funnel for each room or fire-place, to bend and turn the funnel of an upper room fo as to make it enter the fide of another funnel that comes from below. By thefe means the upper room funnel is made fhort of courfe, fince its length can only be reckoned from the place where it enters the lower room funnel; and that funnel is alfo fhortened by all the diftance between the entrance of the fecond funnel and the top of the ftack: for all that part being readily fupplied with air through the fecond funnel, adds no ftrength to the draft, efpecially as that air is cold when there is no fire in the fecond chimney. The only eafy remedy here is, to keep the opening of that funnel fhut in which there is no fire.

4. Another very common caufe of the fmoking of chimneys is, *their overpowering one another.* For inftance, if there be two chimneys in one large room, and you make fires in both of them, the doors and windows clofe fhut, you will find that the greater and ftronger fire fhall overpower the weaker, from the funnel of which it will draw air down to fupply its own demand; which air defcending in the weaker funnel, will drive down its fmoke, and force it into the room. If, inftead of being in one room, the two chimneys are in two different rooms, communicating by a door, the cafe is the fame whenever that door is open. In a very tight houfe, a kitchen chimney on the loweft floor, when it had a great fire in it, has been known to overpower any other chimney in the houfe, and draw air and fmoke into its room as often as the door communicating with the ftaircafe was opened.

Remedy. Take care that every room have the means of fupplying itfelf from without with the air which its chimney may require, fo that no one of them may be obliged to borrow from another, nor under the neceffity of lending. A variety of thefe means have been already defcribed.

5. Another caufe of fmoking is, *when the tops of chimneys are commanded by higher buildings, or by a hill,* fo that the wind blowing over fuch eminences falls like water over a dam, fometimes almoft perpendicularly on the

Smoke. the tops of the chimneys that lie in its way, and beats down the ſmoke contained in them.

Fig. 3. To illuſtrate this, let A (fig. 3.) repreſent a ſmall building at the ſide of a great rock B, and the wind coming in the direction CD; when the current of air comes to the point D, being hurried forward with great velocity, it goes a little forward, but ſoon deſcends downward, and gradually is reflected more and more inward, as repreſented by the dotted lines EE, &c. ſo that, deſcending downwards upon the top of the chimney A, the ſmoke is beat back again into the apartments.

It is evident that houſes ſituated near high hills or thick woods will be in ſome meaſure expoſed to the ſame inconvenience; but it is likewiſe plain, that if a houſe be ſituated upon the ſlope of a hill (as at F, fig. 3.), it will not be in any danger of ſmoke when the wind blows towards that ſide of the hill upon which it is ſituated; for the current of air coming over the houſe-top in the direction GH, is immediately changed by the ſlope of the hill to the direction HC, which powerfully draws the ſmoke upward from the top of the chimney. But it is alſo evident, that a houſe in this ſituation will be liable to ſmoke when the wind blows from the hill; for the current of air coming downward in the direction CH, will beat downward on the chimney F, and prevent the ſmoke from aſcending with freedom. The effect will be much heightened if the doors and windows are chiefly in the lowermoſt ſide of the houſe.

Remedy. That commonly applied to this caſe is a turncap made of tin or plate iron, covering the chimney above and on three ſides, open on one ſide, turning on a ſpindle; and which being guided or governed by a vane always preſents its back to the current. This may be generally effectual, though not certain, as there may be caſes in which it will not ſucceed. Raiſing your funnels if practicable, ſo as their tops may be higher, or at leaſt equal, with the commanding eminence, is more to be depended on. But the turning cap, being eaſier and cheaper, ſhould firſt be tried. "If obliged to build in ſuch a ſituation, I would chooſe (ſays Dr Franklin) to place my doors on the ſide next the hill, and the backs of my chimneys on the fartheſt ſide; for then the column of air falling over the eminence, and of courſe preſſing on that below, and forcing it to enter the doors or *was-iſt-das*es on that ſide, would tend to balance the preſſure down the chimneys, and leave the funnels more free in the exerciſe of their functions."

6. There is another caſe which is the reverſe of that laſt mentioned. It is where the commanding eminence is farther from the wind than the chimney commanded. To explain this a figure may be neceſſary. Suppoſe then a building whoſe ſide AB happens to be expoſed to the wind, and forms a kind of dam againſt its progreſs. Suppoſe the wind blowing in the direction FE. The air obſtructed by this dam or building AB will like water preſs and ſearch for paſſages through it; but finding none, it is beat back with violence, and ſpreads itſelf on every ſide, as is repreſented by the curved lines *e, e, e, e, e, e*. It will therefore force itſelf down the ſmall chimney C, in order to get through by ſome door or window open on the other ſide of the building. And if there be a fire in ſuch chimney, its ſmoke is of courſe beat down, and fills the room.

Remedy. There is but one remedy, which is to raiſe ſuch a funnel higher than the roof, ſupporting it if neceſſary by iron bars. For a turncap in this caſe has no effect, the dammed-up air preſſing down through it in whatever poſition the wind may have placed its opening.

Dr Franklin mentions a city in which many houſes are rendered ſmoky by this operation. For their kitchens being built behind, and connected by a paſſage with the houſes, and the tops of the kitchen-chimneys lower than the tops of the houſes, the whole ſide of a ſtreet when the wind blows againſt its back forms ſuch a dam as above deſcribed; and the wind ſo obſtructed forces down thoſe kitchen-chimneys (eſpecially when they have but weak fires in them) to paſs through the paſſage and houſe into the ſtreet. Kitchen-chimneys ſo formed and ſituated have another inconvenience. In ſummer, if you open your upper room windows for air, a light breeze blowing over your kitchen-chimney towards the houſe, though not ſtrong enough to force down its ſmoke as aforeſaid, is ſufficient to waft it into your windows, and fill the rooms with it; which, beſides the diſagreeableneſs, damages your furniture.

7. Chimneys, otherwiſe drawing well, are ſometimes made to ſmoke by *the improper and inconvenient ſituation of a door.* When the door and chimney are on the ſame ſide of the room, if the door being in the corner is made to open againſt the wall, which is common, as being there, when open, more out of the way, it follows, that when the door is only opened in part, a current of air ruſhing in paſſes along the wall into and acroſs the opening of the chimney, and flirts ſome of the ſmoke out into the room. This happens more certainly when the door is ſhutting, for then the force of the current is augmented, and becomes very inconvenient to thoſe who, warming themſelves by the fire, happen to ſit in its way.

The *remedies* are obvious and eaſy. Either put an intervening ſcreen from the wall round great part of the fireplace; or, which is perhaps preferable, ſhift the hinges of your door, ſo as it may open the other way, and when open throw the air along the other wall.

8. A room that has no fire in its chimney is ſometimes filled with *ſmoke which is received at the top of its funnel, and deſcends into the room.* Funnels without fires have an effect according to their degree of coldneſs or warmth on the air that happens to be contained in them. The ſurrounding atmoſphere is frequently changing its temperature; but ſtacks of funnels covered from winds and ſun by the houſe that contains them, retain a more equal temperature. If, after a warm ſeaſon, the outward air ſuddenly grows cold, the empty warm funnels begin to draw ſtrongly upward; that is, they rarefy the air contained in them, which of courſe riſes, cooler air enters below to ſupply its place, is rarefied in its turn, and riſes; and this operation continues till the funnel grows cooler, or the outward air warmer, or both, when the motion ceaſes. On the other hand, if after a cold ſeaſon the outward air ſuddenly grows warm and of courſe lighter, the air contained in the cool funnels being heavier deſcends into the room; and the warmer air which enters their tops being cooled in its turn, and made heavier, continues to deſcend; and this operation goes on till the funnels are warmed by the paſſing of warm air through them, or the air itſelf grows

cooler. When the temperature of the air and of the funnels is nearly equal, the difference of warmth in the air between day and night is sufficient to produce these currents: the air will begin to ascend the funnels as the cool of the evening comes on, and this current will continue till perhaps nine or ten o'clock the next morning, when it begins to hesitate; and as the heat of the day approaches, it sets downwards, and continues so till towards evening, when it again hesitates for some time, and then goes upwards constantly during the night, as before mentioned. Now when smoke issuing from the tops of neighbouring funnels passes over the tops of funnels which are at the time drawing downwards, as they often are in the middle part of the day, such smoke is of necessity drawn into these funnels, and descends with the air into the chamber.

The remedy is to have a sliding plate that will shut perfectly the offending funnel. Dr Franklin has thus described it: "The opening of the chimney is contracted by brick-work faced with marble slabs to about two feet between the jams, and the breast brought down to within about three feet of the hearth. An iron frame is placed just under the breast, and extending quite to the back of the chimney, so that a plate of the same metal may slide horizontally backwards and forwards in the grooves on each side of the frame. This plate is just so large as to fill the whole space, and shut the chimney entirely when thrust quite in, which is convenient when there is no fire. Draw it out, so as to leave between its further edge and the back a space of about two inches; this space is sufficient for the smoke to pass; and so large a part of the funnel being stopt by the rest of the plate, the passage of warm air out of the room, up the chimney, is obstructed and retarded; and by those means much cold air is prevented from coming in through crevices, to supply its place. This effect is made manifest three ways. 1. When the fire burns briskly in cold weather, the howling or whistling noise made by the wind, as it enters the room through the crevices, when the chimney is open as usual, ceases as soon as the plate is slid in to its proper distance. 2. Opening the door of the room about half an inch, and holding your hand against the opening, near the top of the door, you feel the cold air coming in against your hand, but weakly, if the plate be in. Let another person suddenly draw it out, so as to let the air of the room go up the chimney, with its usual freedom where chimneys are open, and you immediately feel the cold air rushing in strongly. 3. If something be set against the door, just sufficient, when the plate is in, to keep the door nearly shut, by resisting the pressure of the air that would force it open: then, when the plate is draw out, the door will be forced open by the increased pressure of the outward cold air endeavouring to get in to supply the place of the warm air that now passes out of the room to go up the chimney. In our common open chimneys, half the fuel is wasted, and its effect lost; the air it has warmed being immediately drawn off."

9. Chimneys which generally draw well, do nevertheless sometimes give smoke into the rooms, *it being driven down by strong winds passing over the tops of their funnels*, though not descending from any commanding eminence. This case is most frequent where the funnel is short and the opening turned from the wind. It is the more grievous, when it happens to be a cold wind that produces the effect, because when you most want your fire you are sometimes obliged to extinguish it. To understand this, it may be considered that the rising light air, to obtain a free issue from the funnel, must push out of its way or oblige the air that is over it to rise. In a time of calm or of little wind this is done visibly; for we see the smoke that is brought up by that air rise in a column above the chimney: but when a violent current of air, that is, a strong wind, passes over the top of a chimney, its particles have received so much force, which keeps them in a horizontal direction and follow each other so rapidly, that the rising light air has not strength sufficient to oblige them to quit that direction and move upwards to permit its issue.

Remedies. In Venice, the custom is to open or widen the top of the flue, rounding it in the true form of a funnel. In other places the contrary is practised; the tops of the flues being narrowed inwards, so as to form a slit for the issue of the smoke, long as the breadth of the funnel, and only four inches wide. This seems to have been contrived on a supposition that the entry of the wind would thereby be obstructed and perhaps it might have been imagined, that the whole force of the rising warm air being condensed, as it were, in the narrow opening, would thereby be strengthened, so as to overcome the resistance of wind. This, however, did not always succeed; for when the wind was at north-east and blew fresh, the smoke was forced down by fits into the room where Dr Franklin commonly sat, so as to oblige him to shift the fire into another. The position of the slit of this funnel was indeed north-east and south-west. Perhaps if it had lain across the wind, the effect might have been different. But on this we can give no certainty. It seems a matter proper to be referred to experiment. Possibly a turncap might have been serviceable, but it was not tried.

With all the science, however, that a man shall suppose himself possessed of in this article, he may sometimes meet with cases that shall puzzle him. "I once lodged (says Dr Franklin) in a house at London, which in a little room had a single chimney and funnel. The opening was very small, yet it did not keep in the smoke, and all attempts to have a fire in this room were fruitless. I could not imagine the reason, till at length observing that the chamber over it, which had no fireplace in it, was always filled with smoke when a fire was kindled below, and that the smoke came through the cracks and crevices of the wainscot; I had the wainscot taken down, and discovered that the funnel which went up behind it had a crack many feet in length, and wide enough to admit my arm; a breach very dangerous with regard to fire, and occasioned probably by an apparent irregular settling of one side of the house. The air entering this breech freely, destroyed the drawing force of the funnel. The remedy would have been, filling up the breach, or rather rebuilding the funnel: but the landlord rather chose to stop up the chimney.

"Another puzzling case I met with at a friend's country house near London. His best room had a chimney in which, he told me, he never could have a fire, for all the smoke came out into the room. I flattered myself I could easily find the cause and prescribe the cure. I opened the door, and perceived it was not want of air. I made a temporary contraction of the opening of the chimney, and found that it was not its

being

Smoke, Smoke-Jack.

being too large that caufed the fmoke to iffue. I went out and looked up at the top of the chimney: Its funnel was joined in the fame ftack with others; fome of them fhorter, that drew very well, and I faw nothing to prevent its doing the fame. In fine, after every other examination I could think of, I was obliged to own the infufficiency of my fkill. But my friend, who made no pretenfion to fuch kind of knowledge, afterwards difcovered the caufe himfelf. He got to the top of the funnel by a ladder, and looking down found it filled with twigs and ftraw cemented by earth and lined with feathers. It feems the houfe after being built, had ftood empty fome years before he occupied it; and he concluded that fome large birds had taken the advantage of its retired fituation to make their neft there. The rubbifh, confiderable in quantity, being removed, and the funnel cleared, the chimney drew well, and gave fatisfaction."

Chimneys whofe funnels go up in the north wall of a houfe, and are expofed to the north winds, are not fo apt to draw well as thofe in a fouth wall; becaufe when rendered cold by thofe winds, they draw downwards.

Chimneys inclofed in the body of a houfe are better than thofe whofe funnels are expofed in cold walls.

Chimneys in ftacks are apt to draw better than feparate funnels, becaufe the funnels that have conftant fires in them warm the others in fome degree that have none.

SMOKE Jack. This ingenious machine is of German origin, and Meffinger, in his *Collection of Mechanical Performances*, fays it is very ancient, being reprefented in a painting at Nurenbergh, which is known to be older than the year 1350.

Plate cccxcvii. Fig. 5.

Its conftruction is abundantly fimple. An upright iron fpindle GA (fig. 5.), placed in the narrow part of the kitchen chimney, turns round on two points H and I. The upper one H paffes through an iron bar, which is built in acrofs the chimney; and the lower pivot I is of tempered fteel, and is conical or pointed, refting in a conical bell-metal focket fixed on another crofs bar. On the upper end of the fpindle is a circular fly G, confifting of 4, 6, 8, or more thin iron plates, fet obliquely on the fpindle like the fails of a windmill, as we fhall defcribe more particularly by and by. Near the lower end of the fpindle is a pinion A, which works in the teeth of a contrate or face wheel B, turning on a horizontal axis BC. One pivot of this axis turns in a cock fixed on the crofs bar, which fupports the lower end of the upright fpindle HI, and the other pivot turns in a cock fixed on the fide wall of the chimney; fo that this axle is parallel to the front of the chimney. On the remote end of this horizontal axle there is a fmall pulley C, having a deep angular groove. Over this pulley there paffes a chain CDE, in the lower bight of which hangs the large pulley E of the fpit. This end of the fpit turns loofely between the branches of the fork of the rack or raxe F, but without refting on it. This is on the top of a moveable ftand, which can be fhifted nearer to or farther from the fire. The other end turns in one of the notches of another rack. The number of teeth in the pinion A and wheel B, and the diameters of the pulleys C and E, are fo proportioned that the fly G makes from 12 to 20 turns for one turn of the fpit.

Smoke-Jack.

The manner of operation of this ufeful machine is eafily underftood. The air which contributes to the burning of the fuel, and paffes through the midft of it, is greatly heated, and expanding prodigioufly in bulk, becomes lighter than the neighbouring air, and is therefore pufhed by it up the chimney. In like manner, all the air which comes near the fire is heated, expanded, becomes lighter, and is driven up the chimney. This is called the *draught* or *fuction*, but would with greater propriety be termed the *drift* of the chimney. As the chimney gradually contracts in its dimenfions, and as the fame quantity of heated air paffes through every fection of it, it is plain that the rapidity of its afcent muft be greateft in the narroweft place. There the fly G fhould be placed, becaufe it will there be expofed to the ftrongeft current. The air, ftriking the fly vanes obliquely, pufhes them afide, and thus turns them round with a confiderable force. If the joint of meat is exactly balanced on the fpit, it is plain that the only refiftance to the motion of the fly is what arifes from the friction of the pivots of the upright fpindle, the friction of the pinion and wheel, the friction of the pivots of the horizontal axis, the friction of the fmall end of the fpit, and the friction of the chain in the top pulleys. The whole of this is but a mere trifle. But there is frequently a confiderable inequality in the weight of the meat on different fides of the fpit: there muft therefore be a fufficient overplus of force in the impulfe of the afcending air on the vanes of the fly, to overcome this want of equilibrium occafioned by the unfkilfulnefs or negligence of the cook. There is, however, commonly enough of power when the machine is properly conftructed. The utility of this machine will, we hope, procure us the indulgence of fome of our readers, while we point out the circumftances on which its performance depends, and the maxims which fhould be followed in its conftruction.

The upward current of air is the moving power, and fhould be increafed as much as poffible, and applied in the moft advantageous manner. Every thing will increafe the current which improves the draught of the chimney, and fecures it from fmoking. A fmoky chimney muft always have a weak current. For this particular, therefore, we refer to what has been delivered in the article PNEUMATICS, N° 359; and the article SMOKE.

With refpect to the manner of applying this force, it is evident that the beft conftruction of a windmill fails will be nearly the beft conftruction for the fly. According to the ufual theory of the impulfe of fluids, the greateft effective impulfe (that is, in the direction of the fly's motion) will be produced if the plane of the vane be inclined to the axis in an angle of 54 degrees 46 minutes. But, fince we have pronounced this theory to be fo very defective, we had better take a determination founded on the experiments on the impulfe of fluids made by the academy of Paris. Thefe authorife us to fay, that 49½ or 50 degrees will be the beft angle to give the vane: but this muft be underftood only of that part of it which is clofe adjoining to the axis. The vane itfelf muft be twifted, or *weathered* as the millwrights term it, and muft be much more oblique at its outer extremity. The exact pofition cannot be determined with any precifion: becaufe this depends on the

prop rtion

Smoke-Jack.

proportion of the velocity of the vane to that of the current of heated air. This is fubject to no rule, being changed according to the load of the jack. We imagine that an obliquity of 65 degrees for the outer ends of the vanes will be a good pofition for the generality of cafes. Meffinger defcribes an ingenious contrivance for changing this angle at pleafure, in order to vary the velocity of the motion. Each vane is made to turn round a midrib, which ftands out like a radius from the fpindle, and the vane is moved by a ftiff wire attached to one of the corners adjoining to the axle. Thefe wires are attached to a ring which flides on the fpindle like the fpreader of an umbrella; and it is ftopped on any part of the fpindle by a pin thruft through a hole in the fpindle and ring. We mention this briefly, it being eafily underftood by any mechanic, and but of little confequence, becaufe the machine is not fufceptible of much precifion.

It is eafy to fee that an increafe of the furface of the vanes will increafe the power: therefore they fhould occupy the whole fpace of the circle, and not confift of four narrow arms like the fails of a windmill. It is better to make many narrow vanes than a few broad ones; as will appear plain to one well acquainted with the mode of impulfe of fluids acting obliquely. We recommend eight or twelve at leaft; and each vane fhould be fo broad, that when the whole is held perpendicular between the eye and the light, no light fhall come through the fly, the vanes overlapping each other *a very fmall matter*. We alfo recommend the making them of ftiff plate. Their weight contributes to the fteady motion, and enables the fly, which has acquired a confiderable velocity during a favourable pofition of things, to retain a momentum fufficient to pull round the fpit while the heavy fide of the meat is rifing from its loweft pofition. In fuch a fituation a light fly foon lofes its momentum, and the jack ftaggers under its load.

It is plain, from what has been faid, that the fly fhould occupy the whole of that fection of the vent where it is placed. The vent muft therefore be brought to a round form in that place, that none of the current may pafs ufelefsly by it.

It is an important queftion where the fly fhould be placed. If in a wide part of the vent, it will have a great furface, and act by a long lever; but the current in that place is flow, and its impulfe weak. This is a fit fubject of calculation. Suppofe that we have it in our choice to place it either as it is drawn in the figure, or farther up at *g*, where its diameter muft be one half of what it is at G. Since the fame quantity of heated air paffes through both fections, and the fection *g* has only one-fourth of the area of the fection G, it is plain that the air muft be moving four times fafter, and that its impulfe is 16 times greater. But the furface on which it is acting is the fourth part of that of the fly G; the actual impulfe therefore is only four times greater, fuppofing both flies to be moving with the fame relative velocity in refpect of the current; that is, the rim of each moving with the fame portion of the velocity of the current. This will be the cafe when the fmall fly turns eight times as often in a minute as the large fly: for the air is moving four times as quick at *g*, and the diameter of *g* is one-half of that of G. Therefore, when the fmall fly is turning eight times as quick as the great one, there is a quadruple impulfe acting at half the diftance from the axis. The momentum or energy therefore of the current is double. Therefore, fuppofing the pinion, wheel, and pulleys of both jacks to be the fame, the jack with the fmall fly, placed in the narrow part of the vent, will be 16 times more powerful.

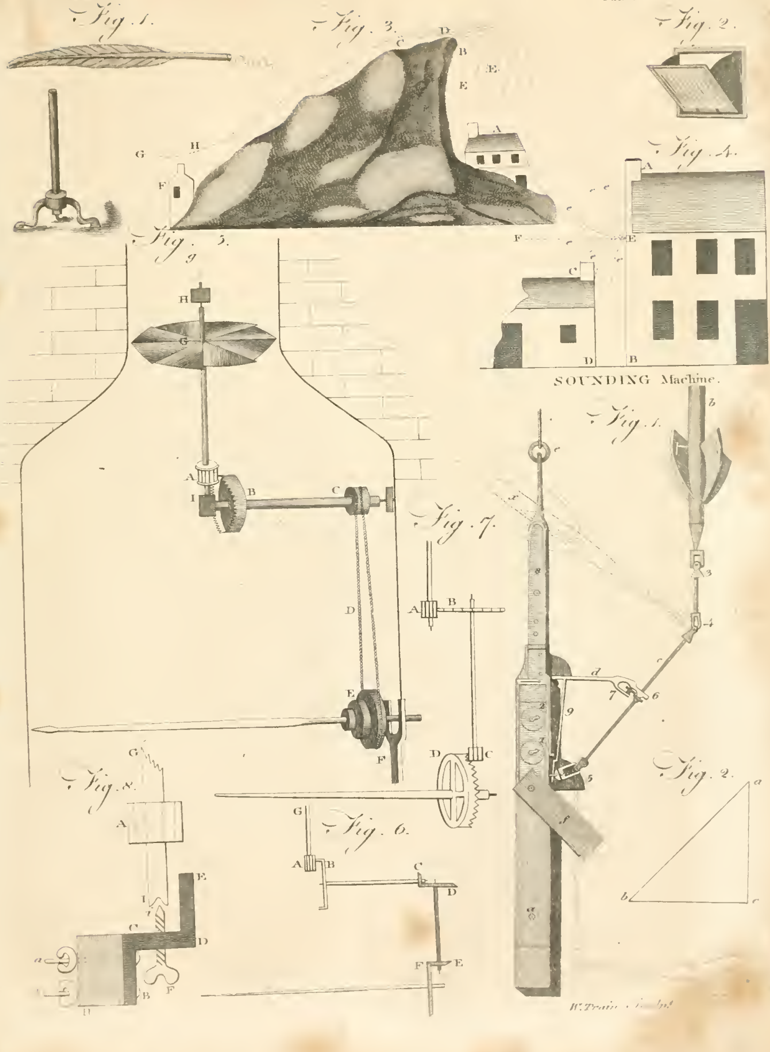
By this example, more eafily underftood than a general procefs, it appears that it is of particular importance to place the fly in an elevated part of the vent, where the area may be much contracted. In order ftill farther to increafe the power of the machine, it would be very proper to lengthen the fpindle ftill more, and to put another fly on it at a confiderable diftance above the firft, and a third above this, &c.

As the velocity of the current changes by every change of the fire, the motion of this jack muft be very unfteady. To render it as adjuftable as may be to the particular purpofe of the cook, the pulley E has feveral grooves of different diameters, and the fpit turns more or lefs flowly, by the fame motion of the fly, according as it hangs in the chain by a larger or fmaller pulley or groove.

Such is the conftruction of the fmoke-jack in its moft fimple form. Some are more artificial and complicated, having, in place of the pulleys and connecting chain, a fpindle coming down from the horizontal axis BC. On the upper end of this fpindle is a horizontal contrate wheel, driven by a pinion in place of the pulley C. On the lower end is a pinion, driving a contrate wheel in place of the pulley E. This conftruction is reprefented in fig. 6. Others are conftructed more fimply, in Fig. 6.
the manner reprefented in fig. 7. But our firft con- Fig. 7.
ftruction has great advantage in point of fimplicity, and allows a more eafy adjuftment of the fpit, which may be brought nearer to the fire or removed farther from it without any trouble; whereas, in the others, with a train of wheels and pinions, this cannot be done without feveral changes of pins and fcrews. The only imperfection of the pulley is, that by long ufe the grooves become flippery, and an ill-balanced joint is apt to hold back the fpit, while the chain flides in the grooves. This may be completely prevented by making the grooves flat inftead of angular (which greatly diminifhes the friction), and furnifhing them with fhort ftuds or pins which take into every third or fourth link of the chain. If the chain be made of the fimpleft form, with flat links, and each link be made of an exact length (making them all on a mould), the motion will be as eafy as with any wheelwork, and without the leaft chance of flipping.

It is always of importance to avoid this flipping of the chain by balancing the loaded fpit. For this purpofe it will be extremely convenient to have what is called a *balance-fkewer*. Let a part of the fpit, immediately adjoining to the pulley, be made round, and let an arm be made to turn on it ftiffly, fo that it may be made faft in any pofition by a fcrew. Let a leaden ball be made to flide along this arm, with a fcrew to faften it at any diftance from the fpit. When the meat is fpitted, lay it on the racks, and the heavieft fide will immediately place itfelf undermoft. Now turn round the balance-fkewer, fo that it may point ftraight upwards, and make it faft in that pofition by the fcrew. Put the leaden ball on it, and flide it inwards or outwards

Plate CCCCXCVII.



Smoke-Jack.

wards till it exactly balances the heavy side, which will appear by the spit's remaining in any position in which it is put.

The greatest difficulty is to keep the machine in repair. The essential part of it, the first mover, the fly, and the pinion and wheel, by which its motion is transmitted to the rest of the machine, are situated in a place of difficult access, and where they are exposed to violent heat and to the smoke and soot. The whole weight of the fly, resting on the lower pivot I, must exert a great pressure there, and occasion great friction, even when this pinion is reduced to the smallest size that is compatible with the necessary strength. The pivot must be of hardened steel, tapered like an obtuse cone, and must turn in a conical socket, also of hardened steel or of bell-metal; and this seat of pressure and friction must be continually supplied with oil, which it consumes very quickly. It is not sufficient that it be from time to time smeared with an oiled feather; there must be an iron cup formed round the socket, and kept filled with oil. It is surprising how quickly it disappears; it soon becomes clammy by evaporation, and by the soot which gathers about it. The continued rubbing of the pivot and socket wears them both very fast; and this is increased by hard powders, such as sandy dust, that are hurried up by the rapid current every time that the cook stirs the fire. These, getting between the rubbing parts, cause them to grind and wear each other prodigiously. It is a great improvement to invert these rubbing parts. Let the lower end of the spindle be of a considerable thickness, and have a conical hollow nicely drilled in its extremity. Let a blunt-pointed conical pin rise up in the middle of the oil cup, on which the conical hollow of the spindle may rest. Here will be the same steady support, and the same friction as in the other way; but no grinding dust can now lodge between the pivot and its socket: and if this upright pin be screwed up through the bottom of the cup, it may be screwed farther up in proportion as it wears; and thus the upper pivot *g* will never desert its hole, a thing which soon happens in the common way. We can say from experience, that a jack constructed in this way will not require the fifth part of the repairs of one done in the other way.

It is of importance that the whole be so put together as to be easily taken down, in order to sweep the vent, or to be repaired, &c. For this purpose, let the cross bar which carries the lower end of the upright spindle be placed a little on one side of the perpendicular line from the upper pivot hole. Let the cock which carries the oil-cup and the pivot of the horizontal axis BC be screwed to one side of this cross bar, so that the centre of the cup may be exactly under the upper pivot hole. By this construction we have only to unscrew this cock, and then both axles come out of their places at once, and may be replaced without any trouble. We have sketched in fig. 8. the manner in which this may be done, where M represents a section of the lower cross bar. BCDE is the cock, fixed to the bar by the pins which go through both, with finger nuts *a* and *b* on the opposite side. F *i* is the hard steel pin with the conical top *i*, on which the lower end I of the upright spindle AG rests, in the manner recommended as the best and most durable. The pivot of the horizontal axis turns in a hole at E the top of the cock.

Fig. 8.

After all, we must acknowledge that the smoke-jack is inferior to the common jack that is moved by a weight. It is more expensive at first, and requires more frequent repairs; its motion is not so much under command; it occasions soot to be thrown about the fire, to the great annoyance of the cook; and it is a great encumbrance when we would clean the vent.

Smoke-Jack || Smollet.

SMOKE-Farthings. The pentecostals or customary oblations offered by the dispersed inhabitants within a diocese when they made their procession to the mother or cathedral church, came by degrees into a standing annual rent called *smoke-farthings*.

SMOKE-Silver. Lands were holden in some places by the payment of the sum of 6d. yearly to the sheriff, called *smoke-silver* (Par. 4. Edw. VI.). Smoke-silver and smoke-penny are to be paid to the ministers of divers parishes as a *modus* in lieu of tithe-wood: and in some manors formerly belonging to religious houses, there is still paid, as appendant to the said manors, the ancient Peter-pence, by the name of *smoke-money* (*Twisd. Hist. Vindicat.* 77.).—The bishop of London *anno* 1444 issued out his commission, *Ad levandum le* smoke-farthings, &c.

SMOLENSKO, a large and strong city of Russia, and capital of a palatinate of the same name, with a castle seated on a mountain, and a bishop's see. It is strong by its situation, being in the middle of a wood, and surrounded by almost inaccessible mountains. It has been taken and retaken several times by the Poles and Russians; but these last have had possession of it ever since the year 1687. It is seated on the river Nieper, near the frontiers of Lithuania, 188 miles south-west of Moscow. E. Long. 31. 22. N. Lat. 54. 50.

SMOLENSKO, a duchy and palatinate of Russia, bounded on the north by Biela, on the east by the duchy of Moscow, on the south by that of Severia and the palatinate of Meislaw, and on the west by the same palatinate and by that of Witepsk. It is full of forests and mountains: and the capital is of the same name.

SMOLLET, Dr Tobias, an author whose writings will transmit his name with honour to posterity, was born in the year 1720 at a small village within two miles of Cameron, on the banks of the river Leven. He appears to have received a classical education, and was bred to the practice of physic and surgery; and in the early part of his life served as a surgeon's mate in the navy.

The incidents that befel him during his continuance in this capacity served as a foundation for Roderic Random, one of the most entertaining novels in the English tongue. He was present at the siege of Carthagena; and in the before mentioned novel he has given a faithful, though not very pleasing, account of the management of that ill-conducted expedition, which he censures in the warmest terms, and from circumstances which fell under his own particular observation.

His connection with the sea seems not to have been of long continuance; and it is probable that he wrote several pieces before he became known to the public by his capital productions. The first piece we know of with certainty is a Satire in two parts, printed first in the years 1746 and 1747, and reprinted in a Collection of his Plays and Poems in 1777. About this period, or some time before, he wrote for Mr Rich an opera intitled Alceste, which has never been performed nor printed.

At

Smollet.

At the age of 18 he wrote a tragedy intitled The Regicide, founded on the ftory of the affaffination of James I. of Scotland. In the preface to this piece, publifhed by fubfcription in the year 1749, he bitterly exclaimed againft falfe patrons, and the duplicity of theatrical managers. The warmth and impetuofity of his temper hurried him, on this occafion, into unjuft reflections againft the late George Lord Lyttleton and Mr Garrick: the character of the former he characterifed in the novel of Peregrine Pickle, and he added a burlefque of the Monody written by that nobleman on the death of his lady. Againft Mr Garrick he made illiberal ill-founded criticifms; and in his novel of Roderic Random gave a very unfair reprefentation of his treatment of him refpecting this tragedy. Of this conduct he afterwards repented, and acknowledged his errors; though in the fubfequent editions of the novel the paffages which were the hafty effufions of difappointment were not omitted.

However, in giving a fketch of the liberal arts in his Hiftory of England, he afterwards remarked, "the exhibitions of the ftage were improved to the moft exquifite entertainment by the talents and management of Garrick, who greatly furpaffed all his predeceffors of this and perhaps every other nation, in his genius for acting, in the fweetnefs and variety of his tones, the irrefiftible magic of his eye, the fire and vivacity of his action, the eloquence of attitude, and the whole pathos of expreffion.

Not fatisfied with this public declaration, he wrote an apology to Mr Garrick in ftill ftronger terms. With thefe ample conceffions, Mr Garrick was completely fatisfied; fo that in 1757, when Dr Smollet's comedy of the Reprifals, an afterpiece of two acts, was performed at Drury Lane theatre, the latter acknowledged himfelf highly obliged for the friendly care of Mr Garrick exerted in preparing it for the ftage; and ftill more for his acting the part of Lufignan in Zara for his benefit, on the fixth inftead of the ninth night, to which he was only intitled by the cuftom of the theatre.

The Adventures of Roderic Random, publifhed in 1748, 2 vols 12mo, a book which ftill continues to have a moft extenfive fale, firft eftablifhed the Doctor's reputation. All the firft volume and the beginning of the fecond appear to confift of real incident and character, though certainly a good deal heightened and difguifed. The judge his grandfather, Crab and Potion the two apothecaries, and 'Squire Gawky, were characters well known in that part of the kingdom where the fcene was laid. Captains Oakhum and Whiffle, Doctors Mackfhane and Morgan, were alfo faid to be real perfonages; but their names we have either never learned or have now forgotten. A bookbinder and barber long eagerly contended for being fhadowed under the name of *Strap*. The Doctor feems to have enjoyed a peculiar felicity in defcribing fea characters, particularly the officers and failors of the navy. His Trunnion, Hatchway, and Pipes, are highly finifhed originals; but what exceeds them all, and perhaps equals any character that has yet been painted by the happieft genius of ancient or modern times, is his Lieutenant Bowling. This is indeed nature itfelf; original, *unique*, and *fui generis*.

By the publication of this work the Doctor had acquired fo great a reputation, that henceforth a certain degree of fuccefs was infured to every thing known or fufpected to proceed from his hand. In the courfe of a few years, the Adventures of Peregrine Pickle appeared; a work of great ingenuity and contrivance in the compofition, and in which an uncommon degree of erudition is difplayed, particularly in the defcription of the entertainment given by the Republican Doctor, after the manner of the ancients. Under this perfonage the late Dr Akenfide, author of The Pleafures of Imagination, is fuppofed to be typified; and it would be difficult to determine whether profound learning or genuine humour predominate moft in this epifode. Another epifode of The Adventures of a Lady of Quality, likewife inferted in this work, contributed greatly to its fuccefs, and is indeed admirably executed; the materials, it is faid, the lady herfelf (the celebrated Lady *Vane*) furnifhed.

Thefe were not the only original compofitions of this ftamp with which the Doctor has favoured the public. Ferdinand Count Fathom, and Sir Launcelot Greaves, are ftill in the lift of what may be called *reading novels*, and have gone through feveral editions; but there is no injuftice in placing them in a rank far below the former. No doubt invention, character, compofition, and contrivance, are to be found in both; but then fituations are defcribed which are hardly poffible, and characters are painted which, if not altogether unexampled, are at leaft incompatible with modern manners; and which ought not to be, as the fcenes are laid in modern times.

The laft work which we believe the Doctor publifhed was of much the fame fpecies, but caft into a different form—The Expedition of Humphrey Clinker. It confifts of a feries of letters, written by different perfons to their refpective correfpondents. He has here carefully avoided the faults which may be juftly charged to his two former productions. Here are no extravagant characters nor unnatural fituations. On the contrary, an admirable knowledge of life and manners is difplayed; and moft ufeful leffons are given applicable to interefting but to very common fituations.

We know not whether the remark has been made, but there is certainly a very obvious fimilitude between the characters of the three heroes of the Doctor's chief productions. Roderic Random, Peregrine Pickle, and Matthew Bramble, are all brothers of the fame family. The fame fatirical, cynical difpofition, the fame generofity and benevolence, are the diftinguifhing and characteriftical features of all three; but they are far from being fervile copies or imitations of each other. They differ as much as the Ajax, Diomed, and Achilles of Homer. This was undoubtedly a great effort of genius; and the Doctor feems to have defcribed his own character at the different ftages and fituations of his life.

Before he took a houfe at Chelfea, he attempted to fettle as practitioner of phyfic at Bath; and with that view wrote a treatife on the waters; but was unfuccefsful, chiefly becaufe he could not render himfelf agreeable to the women, whofe favour is certainly of great confequence to all candidates for eminence, whether in medicine or divinity. This, however, was a little extraordinary; for thofe who remembered Dr Smollet at that time, cannot but acknowledge that he was as graceful and handfome a man as any of the age he lived in; befides, Smollet. beſides, there was a certain dignity in his air and manner which could not but inſpire reſpect wherever he appeared. Perhaps he was too ſoon diſcouraged; in all probability, had he perſevered, a man of his great learning, profound ſagacity, and intenſe application, beſides being endued with every other external as well as internal accompliſhment, muſt have at laſt ſucceeded, and, had he attained to common old age, been at the head of his profeſſion.

Abandoning phyſic altogether as a profeſſion, he fixed his reſidence at Chelſea, and turned his thoughts entirely to writing. Yet, as an author, he was not near ſo ſucceſsful as his happy genius and acknowledged merit certainly deſerved. He never acquired a patron among the great, who by his favour or beneficence relieved him from the neceſſity of writing for a ſubſiſtence. The truth is, Dr Smollet poſſeſſed a loftineſs and elevation of ſentiment and character which appear to have diſqualified him for paying court to thoſe who were capable of conferring favours. It would be wrong to call this diſpoſition pride or haughtineſs; for to his equals and inferiors he was ever polite, friendly, and generous. Bookſellers may therefore be ſaid to have been his only patrons; and from them he had conſtant employment in tranſlating, compiling, and reviewing. He tranſlated Gil Blas and Don Quixote, both ſo happily, that all the former tranſlations of theſe excellent productions of genius have been almoſt ſuperſeded by his. His name likewiſe appears to a tranſlation of Voltaire's Proſe Works; but little of it was done by his own hand; he only reviſed it, and added a few notes. He was concerned in a great variety of compilations. His Hiſtory of England was the principal work of that kind. It had a moſt extenſive ſale; and the Doctor is ſaid to have received 2000l. for writing it and the continuation.

In 1755 he ſet on foot the Critical Review, and continued the principal manager of it till he went abroad for the firſt time in the year 1763. He was perhaps too acrimonious ſometimes in the conduct of that work; and at the ſame time diſplayed too much ſenſibility when any of the unfortunate authors attempted to retaliate whoſe works he had perhaps juſtly cenſured.

Among other controverſies in which his engagements in this publication involved him, the moſt material in its conſequences was that occaſioned by his remarks on a pamphlet publiſhed by Admiral Knowles. That gentleman, in defence of his conduct on the expedition to Rochfort, publiſhed a vindication of himſelf; which falling under the Doctor's examination, produced ſome very ſevere ſtrictures both on the performance and on the character of the writer. The admiral immediately commenced a proſecution againſt the printer; declaring at the ſame time that he deſired only to be informed who the writer was, that if he proved to be a gentleman he might obtain the ſatisfaction of one from him. In this affair the Doctor behaved both with prudence and with ſpirit. Deſirous of compromiſing the diſpute with the admiral in an amicable manner, he applied to his friend Mr Wilkes to interpoſe his good offices with his opponent. The admiral, however, was inflexible; and juſt as ſentence was going to be pronounced againſt the printer, the Doctor came into court, avowed himſelf the author of the Strictures, and declared himſelf ready to give Mr Knowles any ſatisfaction he choſe. The admiral immediately commenced a freſh action againſt the Doctor, who was found guilty, fined 100l., and condemned to three months impriſonment in the King's Bench. It is there he is ſaid to have written the Adventures of Sir Launcelot Greaves, in which he has deſcribed ſome remarkable characters, then his fellow-priſoners. Smollet.

When Lord Bute was called to the chief adminiſtration of affairs, he was prevailed upon to write in defence of that nobleman's meaſures; which he did in a weekly paper called the *Briton*. This gave riſe to the famous North Briton; wherein, according to the opinion of the public, he was rather baffled. The truth is, the Doctor did not ſeem to poſſeſs the talents neceſſary for political altercation. He wanted temper and coolneſs; and his friends accuſed his patron of having denied him the neceſſary information, and even neglected the fulfilling of ſome of his other engagements with him. Be that as it will, the Doctor is ſaid not to have forgotten him in his ſubſequent performances.

Beſides the Briton, Dr Smollet is ſuppoſed to have written other pieces in ſupport of the cauſe he eſpouſed. The Adventures of an Atom, in two volumes, are known to be his production.

His conſtitution being at laſt greatly impaired by a ſedentary life and aſſiduous application to ſtudy, he went abroad for his health in June 1763, and continued in France and Italy two years. He wrote an account of his travels in a ſeries of letters to ſome friends, which were afterwards publiſhed in two volumes octavo, 1766. During all that time he appears to have laboured under a conſtant fit of chagrin. A very ſlight peruſal of theſe letters will ſufficiently evince that this obſervation is founded in fact, and is indeed a melancholy inſtance of the influence of bodily diſtemper over the beſt diſpoſition.

His relation of his travels is actually cynical; for which Sterne, in his Sentimental Journey, has animadverted on him under the character of Smelfungus. The Doctor lived to return to his native country: but his health continuing to decline, and meeting with freſh mortifications and diſappointments, he went back to Italy, where he died in October 21. 1771. He was employed, during the laſt years of his life, in abridging the Modern Univerſal Hiſtory, great part of which he had originally written himſelf, particularly the hiſtories of France, Italy, and Germany.

He certainly met with many mortifications and diſappointments; which, in a letter to Mr Garrick, he thus feelingly expreſſes: "I am old enough to have ſeen and obſerved, that we are all playthings of Fortune; and that it depends upon ſomething as inſignificant and precarious as the toſſing up of a halfpenny, whether a man riſes to affluence and honours, or continues to his dying day ſtruggling with the difficulties and diſgraces of life."

It would be needleſs to expatiate on the character of a man ſo well known as Dr Smollet, who has, beſides, given ſo many ſtrictures of his own character and manner of living in his writings, particularly in Humphrey Clinker; where he appears under the appellation of *Mr Serle*, and has an interview with Mr Bramble; and his manner of living is deſcribed in another letter, where young Melford is ſuppoſed to dine with him at his houſe in Chelſea. No doubt he made money by his connec-

Smollet, Smugglers.

tions with the bookſellers; and had he been a rigid economiſt, or endued with the gift of retention (an expreſſion of his own), he might have lived and died very independent. However, to do juſtice to his memory, his difficulties, whatever they were, proceeded not from extravagance or want of economy. He was hoſpitable, but not oſtentatiouſly ſo; and his table was plentiful, but not extravagant. No doubt he had his failings; but ſtill it would be difficult to name a man who was ſo reſpectable for the qualities of his head, or more amiable for the virtues of his heart.

Since his death a monument has been erected to his memory near Leghorn, on which is inſcribed an epitaph written in Latin by his friend Dr Armſtrong, author of The Art of Preſerving Health, and many other excellent pieces. An inſcription written in Latin was likewiſe inſcribed on a pillar erected to his memory on the banks of the Leven, by one of his relations.

To theſe memoirs we are extremely ſorry to add, that ſo late as 1785 the widow of Dr Smollet was reſiding in indigent circumſtances at Leghorn. On this account the tragedy of Venice Preſerved was acted for her benefit at Edinburgh on the 5th of March, and an excellent prologue ſpoken on that occaſion.

The pieces inſerted in the poſthumous collection of Dr Smollet's plays and poems are, The Regicide, a tragedy: The Repriſal, a comedy; Advice and Reproof, two ſatires; The Tears of Scotland; Verſes on a Young Lady; a Love Elegy, in imitation of Tibullus; two Songs; a Burleſque Ode; Odes to Mirth, to Sleep, to Leven Water, to Blue-ey'd Ann, and to Independence.

SMUGGLERS, perſons who import or export prohibited goods without paying the duties appointed by the law.

The duties of cuſtoms, it is ſaid, were originally inſtituted, in order to enable the king to afford protection to trade againſt pirates: they have ſince been continued as a branch of the public revenue. As duties impoſed upon the importation of goods neceſſarily raiſe their price above what they might otherwiſe have been ſold for, a temptation is preſented to import the commodity clandeſtinely and to evade the duty. Many perſons, prompted by the hopes of gain, and conſidering the violation of a poſitive law of this nature as in no reſpect criminal (an idea in which they have been encouraged by a great part of the community, who make no ſcruple to purchaſe ſmuggled goods), have engaged in this illicit trade. It was impoſſible that government could permit this practice, which is highly injurious to the fair trader, as the ſmuggler is enabled to underſell him, while at the ſame time he impairs the national revenue, and thus wholly deſtroys the end for which theſe duties were appointed. Such penalties are therefore inflicted as it was thought would prevent ſmuggling.

[illegible] Law Dictionary, [illegible]

Many laws have been made with this view. If any goods be ſhipped or landed without warrant and preſence of an officer, the veſſel ſhall be forfeited, and the wharfinger ſhall forfeit 100l. and the maſter or mariner of any ſhip inward bound ſhall forfeit the value of the goods: and any carman, porter, or other aſſiſting, ſhall be committed to gaol, till he find ſurety of his good behaviour, or until he ſhall be diſcharged by the court of exchequer (13 & 14 C. II. c. 11.) If goods be relanded after drawback, the veſſel and goods ſhall be forfeited; and every perſon concerned therein ſhall forfeit double the value of the drawback (8 An. c. 13.) Goods taken in at ſea ſhall be forfeited, and alſo the veſſel into which they are taken; and every perſon concerned therein ſhall forfeit treble value (9 G. II. c. 35.) A veſſel hovering near the coaſt ſhall be forfeited, if under 50 tons burden; and the goods ſhall alſo be forfeited, or the value thereof (5 G. III. c. 43.) Perſons receiving or buying run goods ſhall forfeit 20l. (8 G. c. 18.) A concealer of run goods ſhall forfeit treble value (8 G. c. 18.) Offering run goods to ſale, the ſame ſhall be forfeited, and the perſon to whom they are offered may ſeize them; and the perſon offering them to ſale ſhall forfeit treble value (11 G. c. 30.) A porter or other perſon carrying run goods ſhall forfeit treble value (9 G. II. c. 35.) Perſons armed or diſguiſed carrying run goods ſhall be guilty of felony, and tranſported for ſeven years (8 G. c. 18. 9 G. II. c. 35.)

But the laſt ſtatute, 19 G. II. c. 34. is for this purpoſe *inſtar omnium;* for it makes all forcible acts of ſmuggling, carried on in defiance of the laws, or even in diſguiſe to evade them, felony without benefit of clergy: enacting, that if three or more perſons ſhall aſſemble, with fire-arms or other offenſive weapons, to aſſiſt in the illegal exportation or importation of goods, or in reſcuing the ſame after ſeizure, or in reſcuing offenders in cuſtody for ſuch offences: or ſhall paſs with ſuch goods in diſguiſe; or ſhall wound, ſhoot at, or aſſault, any officers of the revenue when in the execution of their duty; ſuch perſons ſhall be felons, without the benefit of clergy.

When we conſider the nature, and ſtill more the hiſtory of mankind, we muſt allow that the enacting of ſevere penal laws is not the way to prevent crimes. It were indeed much to be wiſhed that there were no ſuch thing as a political crime; for the generality of men, but eſpecially the lower orders, not diſcerning the propriety or utility of ſuch laws, conſider them as oppreſſive and tyrannical, and never heſitate to violate them when they can do it with impunity. Inſtead therefore of puniſhing ſmugglers, it would be much better to remove the temptation. But the high duties which have been impoſed upon the importation of many different ſorts of foreign goods, in order to diſcourage their conſumption in Great Britain, have in many caſes ſerved only to encourage ſmuggling; and in all caſes have reduced the revenue of the cuſtoms below what more moderate duties would have afforded. The ſaying of Dr Swift, that in the arithmetic of the cuſtoms two and two, inſtead of making four, make ſometimes only one, holds perfectly true with regard to ſuch heavy duties, which never could have been impoſed, had not the mercantile ſyſtem taught us, in many caſes, to employ taxation as an inſtrument, not of revenue, but of monopoly.

Smith's Wealth of Nations, vol. iii.

The bounties which are ſometimes given upon the exportation of home produce and manufactures, and the drawbacks which are paid upon the re-exportation of the greater part of foreign goods, have given occaſion to many frauds, and to a ſpecies of ſmuggling more deſtructive of the public revenue than any other. In order to obtain the bounty or drawback, the goods, it is well known, are ſometimes ſhipped and ſent to ſea, but

ſoon

soon afterwards clandestinely relanded in some other part of the country.

Heavy duties being imposed upon almost all goods imported, our merchant importers smuggle as much, and make entry of as little as they can. Our merchant exporters, on the contrary, make entry of more than they export; sometimes out of vanity, and to pass for great dealers in goods which pay no duty; and sometimes to gain a bounty or a drawback. Our exports, in consequence of these different frauds, appear upon the customhouse books greatly to overbalance our imports; to the unspeakable comfort of those politicians who measure the national prosperity by what they call the balance of trade.

SMUT, in *Husbandry*, a disease in corn, when the grains, instead of being filled with flour, are full of a stinking black powder. See WHEAT.

SMYRNA, or ISMIR, at present the largest and richest city of Asia Minor, is situated in north latitude 38° 28′, and in E. Long. 27° 25′ from Greenwich, and about 183 miles west by south of Constantinople. The town extends along the shore about half a mile on a gentle declivity. The houses of the English, French, and Dutch consuls are handsome structures; these, with most of those occupied by the Christian merchants, are washed on one side by the sea, forming a street named *Frank-street*, from its being solely inhabited by European Christians. In the year 1763 the whole of this quarter was consumed by fire: the loss sustained by this calamity in merchandise was estimated at a million and a half of Turkish dollars, or near 200,000l. sterling. The port is one of the finest of the Levant, it being able to contain the largest fleet; and indeed there are seldom in it fewer than 100 ships of different nations.

A castle stands at its entrance, and commands all the shipping which sail in or out. There is likewise an old ruinous castle, near a mile in circumference, which stands in the upper part of the city, and, according to tradition, was built by the empress Helena: and near it is an ancient structure, said to be the remains of a palace where the Greek council was held when Smyrna was the metropolis of Asia Minor. They also show the ruins of an amphitheatre, where it is said St Polycarp, the first bishop, fought with lions.

This city is about four miles in circumference, and nearly of a triangular form; but the side next the mountain is much longer than the other sides. The houses are low, and mostly built with clay walls, on account of the earthquakes to which the country is subject; but the caravanseras and some other of the public buildings have an air of magnificence. The streets are wide, and almost a continued bazar, in which a great part of the merchandise of Europe and Asia is exposed to sale, with plenty of provisions; though these are not so cheap as in many other parts of Turkey, on account of the populousness of the place, and the great resort of foreigners. It is said to contain 15,000 Turks 10,000 Greeks, 1800 Jews, 200 Armenians, and 200 Franks: but the whole population is computed at 120,000. The Turks have 19 mosques; two churches belong to the Greeks; one to the Armenians; and the Jews have eight synagogues. The Romanists have three convents. There is also one of the fathers Della Terra Santa. Here resides an archbishop of the Greek church; a Latin bishop who has a salary from Rome, with the title of bishop of Smyrna *in partibus infidelium*; and the English and Dutch factories have each their chaplain.

The walks about the town are extremely pleasant, particularly on the west side of Frank street, where there are several little groves of orange and lemon trees, which being always clothed with leaves, blossoms, and fruit, regale several of the senses at the same time. The vines which cover the little hills about Smyrna afford both a delightful prospect and plenty of grapes, of which good wine is made. These hills are agreeably interspersed with fertile plains, little forests of olives and other fruit-trees, and many pleasure-houses, to which the Franks usually retire during the summer. In the neighbourhood of Smyrna is great plenty of game and wild-fowl, and particularly deer and wild-hogs. The sea also abounds with a variety of good fish. The European Christians are here allowed all imaginable liberties, and usually clothe themselves after the European manner.

The chief commerce of this city consists in raw silk, silk-stuffs, grograms, and cotton yarn.

However, the unhealthfulness of the situation, and more especially the frequent earthquakes, from which, it is said, they are scarcely ever free for two years together, and which have been felt 40 days successively, are an abatement of the pleasure that might otherwise be enjoyed here. A very dreadful one happened in June 1688, which overthrew a great number of the houses; and the rock opening where the castle stood, swallowed it up, and no less than 5000 persons perished on this occasion.

In the year 1758, so desolating a plague raged here, that scarcely a sufficient number of the inhabitants survived to gather in the fruits of the earth. In the year 1772, three-fourth parts of the city were consumed by fire; and six years after it was visited by the most dreadful earthquakes, which continued from the 25th of June to the 5th of July; by which successive calamities the city has been so much reduced, that its former consequence is never likely to be restored.

The ladies here wear the oriental dress, consisting of large trowsers or breeches, which reach to the ancle; long vests of rich silk or velvet, lined in winter with costly furs; and round their waist an embroidered zone with clasps of silver or gold. Their hair is plaited, and descends down the back often in great profusion. The girls have sometimes above twenty thick tresses, besides two or three encircling the head as a coronet, and set off with flowers and plumes of feathers, pearls, or other jewels. They commonly stain it of a chesnut colour, which is the most desired. Their apparel and carriage are alike antique. It is remarkable that the trowsers are mentioned in a fragment of Sappho as part of the female dress.

SMYRNIUM, ALEXANDERS; a genus of plants belonging to the class of pentandria, and to the order of digynia; and in the natural system ranging under the 45th order, *Umbellatæ*. See BOTANY *Index*.

SNAFFLE, in the manege, is a very slender bitmouth without any branches, much used in England; the true bridles being reserved for war.

SNAIL, in *Zoology*. See HELIX, CONCHOLOGY *Index*, and LIMAX, HELMINTHOLOGY *Index*.

SNAKE, in *Zoology*. See ANGUIS and SERPENS, OPHIOLOGY *Index*.

SNAKE-Stones, *Ammonitæ*, in *Natural History*, the name of a large genus of fossil shells, very few if any of which are yet known in their recent state, or living either on our own or any other shores; so that it seems wonderful whence so vast a number and variety of them should be brought into our subterranean regions. They seem indeed dispersed in great plenty throughout the world, but nowhere are found in greater numbers, beauty, and variety, than in our island.

Mr Harenberg found prodigious numbers of them on the banks of a river in Germany. He traced this river through its several windings for many miles, and among a great variety of belemnitæ, cornua ammonis, and cochlitæ, of various kinds; he found also great quantities of wood of recent petrifaction, which still preserved plain marks of the axe by which it had been cut from the trees then growing on the shore. The water of this river he found in dry seasons, when its natural springs were not diluted with rains, to be considerably heavier than common water; and many experiments showed him that it contained ferruginous, as well as stony particles, in great quantity, whence the petrifactions in it appeared the less wonderful, though many of them of recent date.

Of the cornua ammonis, or serpent-stones, he there observed more than 30 different species. They lie immersed in a bluish fossil stone, of a soft texture and fatty appearance, in prodigious numbers, and of a great variety of sizes, from the larger known sorts down to such as could not be seen without very accurate inspection or the assistance of a microscope. Such as lie in the softest of these stones are soft like their matrix, and easily crumble to pieces; others are harder. In a piece of this stone, of the bigness of a finger, it is common to find 30 or more of these fossils; and often they are seen only in form of white specks, so minute that their figure cannot be distinguished till examined by the microscope.

They all consist of several volutæ, which are different in number in the different species, and their striæ also are extremely various; some very deep with very high ridges between them, others very slight; some straight, others crooked; others undulated, and some terminating in dots, tubercles, or cavities, towards the back, and others having tubercles in two or three places. They are all composed of a great number of chambers or cells, in the manner of the *nautilus Græcorum*, each having a communication with the others, by means of a pipe or siphunculus. There is a small white shell fish of Barbadoes, which seems truly a recent animal of this genus; and in the East Indies there is another also, small and grayish; but the large and beautifully marked ones are found only fossil.

They are composed of various fossil bodies, often of quarry stone, sometimes of the matter of the common pyrites, and of a great variety of other substances; and though they appear usually mere stones, yet in some the pearly part of the original shell is preserved in all its beauty. Sometimes also, while the outer substance is of the matter of the pyrites, or other coarse, stony, or mineral matter, the inner cavity is filled with a pure white spar of the common plated texture. This gives a great beauty to the specimen. The cornua ammonis, or snake-stones, are found in many parts of England, particularly in Yorkshire, where they are very plentiful in the alum rocks of several sizes.

SNAKE-Root. See POLYGALA, BOTANY *Index*.

SNAKE-Weed. See POLYGONUM, BOTANY *Index*.

SNAPEDRAGON. See ANTIRRHINUM, BOTANY *Index*.

SNEEZING, a convulsive motion of the muscles of the breast, whereby the air is expelled from the nose with much vehemence and noise. It is caused by the irritation of the upper membrane of the nose, occasioned by acrid substances floating in the air, or by medicines called *sternutatory*.

This irritation is performed either externally, by strong smells, as marjoram, roses, &c. or by dust floating in the air, and taken in by inspiration; or by sharp pungent medicines, as cresses and other sternutatories, which vellicate the membrane of the nose; or internally, by the acrimony of the lympha or mucus, which naturally moistens that membrane. The matters cast forth in sneezing come primarily from the nose and throat; the pituitary membrane continually exuding a mucus thither; and, secondarily, from the breast, the trachea, and the bronchia of the lungs.

The practice of saluting the person who sneezed existed in Africa, among nations unknown to the Greeks and Romans. The accounts we have of Monomotapa inform us *, that when the prince sneezes, all his subjects in the capital are advertised of it, that they may offer up prayers for his safety. The author of the conquest of Peru assures us, that the cacique of Guachoia having sneezed in presence of the Spaniards, the Indians of his train fell prostrate before him, stretched forth their hands, and displayed to him the accustomed marks of respect, while they invoked the sun to enlighten him, to defend him, and to be his constant guard.

* *Strada, Prol. Acad.*

Every body knows that the Romans saluted each other on these occasions: and Pliny relates †, that Tiberius exacted these signs of homage when drawn in his chariot. Superstition, whose influence can debase every thing, had degraded this custom for several ages, by attaching favourable or unfavourable omens to sneezing according to the hour of the day or night, according to the signs of the zodiac, according as a work was more or less advanced, or according as one had sneezed to the right or to the left ‡. If a man sneezed at rising from table or from his bed, it was necessary for him to sit or lie down again. You are struck with astonishment, said Timotheus to the Athenians, who wished to return into the harbour with their fleet §, because he had sneezed; you are struck with astonishment, because among 10,000 there is one man whose brain is moist.

† *Plin. Hist. Nat.* lib. ii. cap. 2.

‡ *Spond. Homeri Comment.*

§ *Frontin.* lib. i. cap. 11.

Polydore Virgil pretends, that in the time of Gregory the Great, there reigned in Italy an epidemic distemper, which carried off by sneezing all those who were seized by it; and that this pontiff ordered prayers to be made against it, accompanied by certain signs of the cross. But besides that, there are very few cases in which sneezing can be considered as dangerous, and that it is frequently a favourable symptom ||: it is evident, that we ought not to date from the sixth century the origin of a custom which loses itself in the obscurity of antiquity. Avicenna and Cardan say, it is a sort of convulsion, which gives occasion to dread an epilepsy, and that

|| *Hippocrat. Halleri Phys.*

that this disease is endeavoured to be warded off by prayers. Clement of Alexandria considers it as a mark of intemperance and effeminacy, which ought to be proscribed. And he inveighs bitterly against those who endeavour to procure sneezing by external aid. Montaigne, on the contrary, explains this fact in a tone rather cynical. It is singular enough, that so many ridiculous, contradictory, and superstitious opinions, have not abolished those customary civilities which are still preserved equally among high and low; and which only the Anabaptists and Quakers have rejected, because they have renounced salutations in every case.

Among the Greeks sneezing was almost always a good omen. It excited marks of tenderness, of respect, and attachment. The genius of Socrates informed him by sneezing, when it was necessary to perform any action *. The young Parthenis, hurried on by her passion, resolved to write to Sarpedon an avowal of her love †; she sneezes in the most tender and impassioned part of her letter: This is sufficient for her; this incident supplies the place of an answer, and persuades her that Sarpedon is her lover. Penelope, harassed by the vexatious courtship of her suitors, begins to curse them all, and to pour forth vows for the return of Ulysses ‡. Her son Telemachus interrupts her by a loud sneeze. She instantly exults with joy, and regards this sign as an assurance of the approaching return of her husband. Xenophon was haranguing his troops; a soldier sneezed in the moment when he was exhorting them to embrace a dangerous but necessary resolution. The whole army, moved by this presage, determine to pursue the project of their general; and Xenophon orders sacrifices to Jupiter the preserver §.

* Plutarch de gen. Socrat.

† Aristenæt.

‡ Homeri Odyss. lib. xvii.

§ Xenoph. Anab.

This religious reverence for sneezing, so ancient and so universal even in the times of Homer, always excited the curiosity of the Greek philosophers and of the rabbins. These last have spread a tradition, that, after the creation of the world, God made a general law to this purport, that every living man should sneeze but once in his life, and that at the same instant he should render up his soul into the hand of his Creator ‖, without any preceding indisposition. Jacob obtained an exemption from the common law, and the favour of being informed of his last hour: He sneezed and did not die; and this sign of death was changed into a sign of life. Notice of this was sent to all the princes of the earth; and they ordained, that in future sneezing should be accompanied with forms of blessing, and vows for the persons who sneezed.

‖ Acad. des Inscrip. vol. iv.

Aristotle remounts likewise to the sources of natural religion. He observes, that the brain is the origin of the nerves, of our sentiments, our sensations, the seat of the soul, the image of the Divinity *; that upon all these accounts, the substance of the brain has ever been held in honour; that the first men swore by their head; that they durst not touch nor eat the brains of any animal; that it was even a sacred word which they dared not to pronounce. Filled with these ideas, it is not wonderful that they extended their reverence even to sneezing. Such is the opinion of the most ancient and sagacious philosophers of Greece.

* Aristot. in Prob.

According to mythology, the first sign of life Prometheus's artificial man gave was by sternutation. This supposed creator is said to have stolen a portion of the solar rays; and filling with them a phial, which he had made on purpose, sealed it up hermetically. He instantly flies back to his favourite automaton, and opening the phial holds it close to the statue; the rays still retaining all their activity, insinuate themselves through the pores, and set the fictitious man a sneezing. Prometheus, transported with the success of his machine, offers up a fervent prayer, with wishes for the preservation of so singular a being. His automaton observed him, remembering his ejaculations, was very careful, on the like occasions, to offer these wishes in behalf of his descendants, who perpetuated it from father to son in all their colonies.

SNIGGLING, a method of fishing for eels, chiefly used in the day-time, when they are found to hide themselves near wears, mills, or flood-gates. It is performed thus: Take a strong line and hook, baited with a garden-worm, and observing the holes where the eels lie hid, thrust your bait into them by the help of a stick; and if there be any, you shall be sure to have a bite; and may, if your tackling hold, get the largest eels.

SNIPE, in *Ornithology*. See Scolopax and Shooting.

SNORING, in *Medicine*, otherwise called *stertor*, is a sound like that of the cerchnon, but greater and more manifest.

Many confound those affections, and make them to differ only in place and magnitude, calling by the name of *stertor* that sound or noise which is heard or supposed to be made in the passage between the palate and the nostrils as in those who sleep; that boiling or bubbling noise, which in respiration proceeds from the larynx or head, or orifice of the aspera arteria, they call *cerchon*; but if the sound comes from the aspera arteria itself, it is called *cerchnos*, that is, as some understand it, a rattling, or as others a stridulous or wheezing roughness of the aspera arteria. In dying persons this affection is called by the Greeks ῥεγχος, *rhenchos*, which is a snoring or rattling kind of noise, proceeding as it were from a conflict between the breath and the humours in the aspera arteria.

This and such like affections are owing to a weakness of nature, as when the lungs are full of pus or humours: to which purpose we read in the Prognostics of Hippocrates, "it is a bad sign when there is no expectoration, and no discharge from the lungs, but a noise as from an ebullition is heard in the aspera arteria from a plenitude of humour." Expectoration is suppressed either by the viscidity of the humour, which requires to be discharged, and which adhering to the aspera arteria, and being there agitated by the breath, excites that bubbling noise or stertor; or by an obstruction of the bronchia; or, lastly, by a compression of the aspera arteria and throat, whence the passage is straitened, in which the humours being agitated, excite such a kind of noise as before described. Hence Galen calls those who are strait-breasted *stertorous*. That author assigns but two causes of this symptom, which are either the straitness of the passage of respiration or redundance of humours, or both together; but it is necessary to add a third, to wit, the weakness of the faculty, which is the cause of the rhenchos in dying persons, where nature is too weak to make discharges.

From what has been said we conclude, that this symptom, or this sort of fervour or ebullition in the throat,

throat, is not always mortal, but only when nature is oppreſſed with the redundance of humour, in ſuch a manner, that the lungs cannot diſcharge themſelves by ſpitting; or the paſſage appointed for the breath (being the aſpera arteria) is very much obſtructed, upon which account many dying perſons labour under a ſtertor with their mouths gaping.

SNOW, a well known meteor, formed by the freezing of the vapour of water in the atmoſphere. It differs from hail and hoar-froaſt, in being as it were cryſtallized, which they are not. This appears on examining a flake of ſnow by a magnifying glaſs; when the whole of it will appear to be compoſed of fine ſhining ſpicula diverging like rays from a centre. As the flakes fall down through the atmoſphere, they are continually joined by more of theſe radiated ſpicula, and thus increaſe in bulk like the drops of rain or hailſtones. Dr Grew, in a diſcourſe of the nature of ſnow, obſerves, that many parts thereof are of a regular figure, for the moſt part ſtars of ſix points, and are as perfect and tranſparent ice as any we ſee on a pond, &c. Upon each of theſe points are other collateral points, ſet at the ſame angles as the main points themſelves: among which there are divers other irregular, which are chiefly broken points, and fragments of the regular ones. Others alſo, by various winds, ſeem to have been thawed and frozen again into irregular cluſters; ſo that it ſeems as if the whole body of ſnow were an infinite maſs of icicles irregularly figured. That is, a cloud of vapours being gathered into drops, the ſaid drops forthwith deſcend; upon which deſcent, meeting with a freezing air as they paſs through a colder region, each drop is immediately frozen into an icicle, ſhooting itſelf forth into ſeveral points; but theſe ſtill continuing their deſcent, and meeting with ſome intermitting gales of warmer air, or in their continual waftage to and fro touching upon each other, ſome of them are a little thawed, blunted, and again frozen into cluſters, or entangled ſo as to fall down in what we call *flakes*.

The lightneſs of ſnow, although it is firm ice, is owing to the exceſs of its ſurface, in compariſon to the matter contained under it; as gold itſelf may be extended in ſurface till it ride upon the leaſt breath of air.

The whiteneſs of ſnow is owing to the ſmall particles into which it is divided; for ice, when pounded, will become equally white. An artificial ſnow has been made by the following experiment. A tall phial of aquafortis being placed by the fire till it is warm, and filings of pure ſilver, a few at a time, being put into it; after a briſk ebullition, the ſilver will diſſolve ſlowly. The phial being then placed in a cold window, as it cools the ſilver particles will ſhoot into cryſtals, ſeveral of which running together will form a flake of ſnow, which will deſcend to the bottom of the phial. While they are deſcending, they repreſent perfectly a ſhower of ſilver ſnow, and the flakes will lie upon one another at the bottom, like real ſnow upon the ground.

According to Signior Beccaria, clouds of ſnow differ in nothing from clouds of rain, but in the circumſtance of cold that freezes them. Both the regular diffuſion of the ſnow, and the regularity of the ſtructure of its parts (particularly ſome figures of ſnow or hail which fall about Turin, and which he calls *roſette*), ſhow that clouds of ſnow are acted upon by ſome uniform cauſe like electricity; and he endeavours to ſhow how electricity is capable of forming theſe figures. He was confirmed in his conjectures by obſerving, that his apparatus for obſerving the electricity of the atmoſphere never failed to be electrified by ſnow as well as rain. Profeſſor Winthrop ſometimes found his apparatus electrified by ſnow when driven about by the wind, though it had not been affected by it when the ſnow itſelf was falling. A more intenſe electricity, according to Beccaria, unites the particles of hail more cloſely than the more moderate electricity does thoſe of ſnow, in the ſame manner as we ſee that the drops of rain which fall from thunder-clouds are larger than thoſe which fall from others, though the former deſcend through a leſs ſpace.

But we are not to conſider ſnow merely as a curious and beautiful phenomenon. The Great Diſpenſer of univerſal bounty has ſo ordered it, that it is eminently ſubſervient, as well as all the works of creation, to his benevolent deſigns. Were we to judge from appearances only, we might imagine, that ſo far from being uſeful to the earth, the cold humidity of ſnow would be detrimental to vegetation. But the experience of all ages aſſerts the contrary. Snow, particularly in thoſe northern regions where the ground is covered with it for ſeveral months, fructifies the earth, by guarding the corn or other vegetables from the intenſer cold of the air, and eſpecially from the cold piercing winds. It has been a vulgar opinion, very generally received, that ſnow fertilizes the lands on which it falls more than rain, in conſequence of the nitrous ſalts which it is ſuppoſed to acquire by freezing. But it appears from the experiments of Margraaf, in the year 1751, that the chemical difference between rain and ſnow water is exceedingly ſmall; that the latter contains a leſs proportion of earth than the former; but neither of them contain either earth or any kind of ſalt in any quantity which can be ſenſibly efficacious in promoting vegetation. Allowing, therefore, that nitre is a fertilizer of lands, which many are upon good grounds diſpoſed utterly to deny, yet ſo very ſmall is the quantity of it contained in ſnow, that it cannot be ſuppoſed to promote the vegetation of plants upon which the ſnow has fallen. The peculiar agency of ſnow, as a fertilizer in preference to rain, may admit of a very rational explanation, without recurring to nitrous ſalts ſuppoſed to be contained in it. It may be rationally aſcribed to its furniſhing a covering to the roots of vegetables, by which they are guarded from the influence of the atmoſpheric cold, and the internal heat of the earth is prevented from eſcaping.

The internal part of the earth, by ſome principle which we do not underſtand, is heated uniformly to the 48th degree of Fahrenheit's thermometer. This degree of heat is greater than that in which the watery juices of vegetables freeze, and it is propagated from the inward parts of the earth to the ſurface, on which the vegetables grow. The atmoſphere being variably heated by the action of the ſun in different climates, and in the ſame climate at different ſeaſons, communicates to the ſurface of the earth and to ſome diſtance below it the degree of heat or cold which prevails in itſelf. Different vegetables are able to preſerve life under different degrees of cold, but all of them periſh when the cold which reaches their roots is extreme. Providence has therefore, in the coldeſt climates, provided a covering

Snow.

of snow for the roots of vegetables, by which they are protected from the influence of the atmospherical cold. The snow keeps in the internal heat of the earth, which surrounds the roots of vegetables, and defends them from the cold of the atmosphere.

Snow or ice water is always deprived of its fixed air, which escapes during the process of congelation. Accordingly, as some of the inhabitants of the Alps who use it for their constant drink have enormous wens upon their throats, it has been ascribed to this circumstance. If this were the cause of these wens, it would be easy to remove it by exposing the snow-water to the air for some time. But several eminent physicians have rejected the notion that snow-water is the cause of these wens; for in Greenland, where snow-water is commonly used, the inhabitants are not affected with such swellings: on the other hand, they are common in Sumatra where snow is never seen.

SNOW, in sea affairs, is generally the largest of all two-masted vessels employed by Europeans, and the most convenient for navigation.

The sails and rigging on the mainmast and foremast of a snow are exactly similar to those on the same masts in a ship; only that there is a small mast behind the mainmast of the former, which carries a sail nearly resembling the mizen of a ship. The root of the mast is fixed on a block of wood on the quarter-deck abaft the mainmast; and the head of it is attached to the aftertop of the maintop. The sail which is called the *trysail* is extended from its mast towards the stern of the vessel.

When the sloops of war are rigged as snows, they are furnished with a horse, which answers the purpose of the trysail-mast, the fore-part of the sail being attached by rings to the said horse, in different parts of its height.

SNOW Grotto, an excavation made by the waters on the side of Mount Etna, by making their way under the layers of lava, and by carrying away the bed of pozzolana below them. It occurred to the proprietor, that this place was very suitable for a magazine of snow: for in Sicily, at Naples, and particularly at Malta, they are obliged for want of ice to make use of snow for cooling their wine, sherbet, and other liquors, and for making sweetmeats.

This grotto was hired or bought by the knights of Malta, who having neither ice nor snow on the burning rock which they inhabit, have hired several caverns on Etna, into which people whom they employ collect and preserve quantities of snow to be sent to Malta when needed. The grotto has therefore been repaired within at the expence of that order; flights of steps are cut into it, as well as two openings from above, by which they throw in the snow, and through which the grotto is enlightened. Above the grotto they have also levelled a piece of ground of considerable extent: this they have inclosed with thick and lofty walls, so that when the winds, which at this elevation blow with great violence, carry the snow from the higher parts of the mountains, and deposit it in the inclosure, it is retained and amassed by the walls. The people then remove it into the grotto through the two openings; and it is there laid up, and preserved in such a manner as to resist the force of the summer heats; as the layers of lava with which the grotto is arched above prevent them from making any impression.

Snow, Snowdon-Hill.

When the season for exporting the snow comes on, it is put into large bags, into which it is pressed as closely as possible; it is then carried by men out of the grotto, and laid upon mules, which convey it to the shore, where small vessels are waiting to carry it away.

But before those lumps of snow are put into bags, they are wrapped in fresh leaves; so that while they are conveyed from the grotto to the shore, the leaves may prevent the rays of the sun from making any impression upon them.

The Sicilians carry on a considerable trade in snow, which affords employment to some thousands of mules, horses, and men. They have magazines of it on the summits of their loftiest mountains, from which they distribute it through all their cities, towns, and houses; for every person in the island makes use of snow. They consider the practice of cooling their liquors as absolutely necessary for the preservation of health; and in a climate the heat of which is constantly relaxing the fibres, cooling liquors, by communicating a proper tone to the fibres of the stomach, must greatly strengthen them for the performance of their functions.

In this climate a scarcity of snow is no less dreaded than a scarcity of corn, wine, or oil. We are informed by a gentleman who was at Syracuse in the year 1777, when there was a scarcity of snow, the people of the town learned that a small vessel loaded with that article was passing the coast: without a moment's deliberation they ran in a body to the shore, and demanded her cargo; which when the crew refused to deliver up, the Syracusans attacked and took, though with the loss of several men.

SNOW-Drop. See CHIONANTHUS, BOTANY *Index*.

SNOWDON HILL, the name of a mountain in Caernarvon-shire in Wales, generally thought to be the highest in Britain; though some have been of opinion that its height is equalled, or even exceeded, by mountains in the Highlands of Scotland. The mountain is surrounded by many others, called in the Welsh language *Crib Coch*, *Crib y Distill*, *Lliweddy yr Arran*, &c.

According to Mr Pennant *, this mountainous tract yields scarcely any corn. Its produce is cattle and sheep; which, during summer, keep very high in the mountains, followed by their owners with their families, who reside during that season in *havodtys*, or "summer dairy-houses," as the farmers in the Swiss Alps do in their *sennes*. These houses consist of a long low room, with a hole at one end to let out the smoke from the fire which is made beneath. Their furniture is very simple; stones are substituted for stools, and their beds are of hay, ranged along the sides. They manufacture their own clothes, and dye them with the *lichen omphaloides* and *lichen parietinus*, mosses collected from the rocks. During summer the men pass their time in tending their herds or in making hay, &c. and the women in milking or in making butter and cheese. For their own use they milk both ewes and goats, and make cheese of the milk. Their diet consists of milk, cheese, and butter; and their ordinary drink is whey; though they have, by way of reserve, a few bottles of very strong beer, which they use as a cordial when sick. They are people of good understanding, wary, and circumspect; tall,

* *Journey to Snowdon.*

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thin, and of ſtrong conſtitutions. In the winter-time they deſcend into the *hen dref*, or "old dwelling," where they paſs their time in inactivity.

The view from the higheſt peak of Snowdon is very extenſive. From it Mr Pennant ſaw the county of Cheſter, the high hills of Yorkſhire, part of the north of England, Scotland, and Ireland; a plain view of the iſle of Man; and that of Angleſea appeared like a map extended under his feet, with every rivulet viſible. Our author took much pains to have this view to advantage; ſat up at a farm on the weſt till about 12, and walked up the whole way. The night was remarkably fine and ſtarry; towards morning the ſtars faded away, leaving an interval of darkneſs, which, however, was ſoon diſpelled by the dawn of day. The body of the ſun appeared moſt diſtinct, with the roundneſs of the moon, before it appeared too brilliant to be looked at. The ſea, which bounded the weſtern part of the proſpect, appeared gilt with the ſun-beams, firſt in ſlender ſtreaks, and at length glowed with redneſs. The proſpect was diſcloſed like the gradual drawing up of a curtain in a theatre; till at laſt the heat became ſufficiently ſtrong to raiſe miſts from the various lakes, which in a ſlight degree obſcured the proſpect. The ſhadow of the mountain extended many miles, and ſhowed its bicapitated form; the Wyddfa making one head, and Crib y Diſtill the other. At this time he counted between 20 and 30 lakes either in Caernarvon or in Merionethſhire. In making another viſit, the ſky was obſcured very ſoon after he got up. A vaſt miſt involved the whole circuit of the mountain, and the proſpect down was horrible. It gave an idea of numbers of abyſſes, concealed by a thick ſmoke furiouſly circulating around them. Very often a guſt of wind made an opening in the clouds, which gave a fine and diſtinct viſta of lake and valley. Sometimes they opened in one place, at others in many at once; exhibiting a moſt ſtrange and perplexing ſight of water, fields, rocks, and chaſms. They then cloſed again, and every thing was involved in darkneſs; in a few minutes they would ſeparate again, and repeat the above-mentioned ſcene with infinite variety. From this proſpect our traveller deſcended with great reluctance; but before he had reached the place where his horſes were left, he was overtaken by a thunder ſtorm. The rolling of the thunder-claps, being reiterated by the mountains, was inexpreſſibly awful; and after he had mounted, he was in great danger of being ſwept away by the torrents which poured down in conſequence of a very heavy rain.

It is very rare (Mr Pennant obſerves) that the traveller gets a proper day to aſcend this hill: it indeed often appears clear; but by the evident attraction of the clouds by this lofty mountain, it becomes ſuddenly and unexpectedly enveloped in miſt, when the clouds have juſt before appeared very high and very remote. At times he obſerved them lower to half their height; and notwithſtanding they have been diſperſed to the right and left, yet they have met from both ſides, and united to involve the ſummit in one great obſcurity.

The height of Snowdon was meaſured, in 1682, by Mr Caſwell, with inſtruments made by Flamſtead: according to his menſuration, the height is 3720 feet; but more modern computations make it only 3568, reckoning from the quay at Caernarvon to the higheſt peak. The ſtone that compoſes this mountain is exceſſively hard. Large coarſe cryſtals, and frequently cubic pyrites, are found in the fiſſures. An immenſe quantity of water ruſhes down the ſides of Snowdon and the neighbouring mountains, inſomuch that Mr Pennant ſuppoſes, if collected into one ſtream, they would exceed the waters of the Thames.

SNUFF, a powder chiefly made of tobacco, the uſe of which is too well known to need any deſcription here.

Tobacco is uſually the baſis of ſnuff; other matter being only added to give it a more agreeable ſcent, &c. The kinds of ſnuff, and their ſeveral names, are infinite, and new ones are daily invented; ſo that it would be difficult, not to ſay impoſſible, to give a detail of them. We ſhall only ſay, that there are three principal ſorts: the firſt granulated; the ſecond an impalpable powder; and the third the bran, or coarſe part remaining after ſifting the ſecond ſort.

"Every profeſſed, inveterate, and incurable ſnuff-taker (ſays Lord Stanhope), at a moderate computation, takes one pinch in ten minutes. Every pinch, with the agreeable ceremony of blowing and wiping the noſe and other incidental circumſtances, conſumes a minute and a half. One minute and a half out of every ten, allowing 16 hours to a ſnuff-taking day, amounts to two hours and 24 minutes out of every natural day, or one day out of every ten. One day out of every 10 amounts to 36 days and a half in a year. Hence if we ſuppoſe the practice to be perſiſted in 40 years, two entire years of the ſnuff-taker's life will be dedicated to tickling his noſe, and two more to blowing it. The expence of ſnuff, ſnuff boxes, and handkerchiefs, will be the ſubject of a ſecond eſſay; in which it will appear, that this luxury encroaches as much on the income of the ſnuff-taker as it does on his time; and that by a proper application of the time and money thus loſt to the public, a fund might be conſtituted for the diſcharge of the national debt." See NICOTIANA.

SNYDERS, FRANCIS, a Flemiſh painter, born at Antwerp in 1579, and bred under his countryman Henry Van Balen. His genius firſt diſplayed itſelf in painting fruit: he afterwards attempted animals, huntings, &c. in which he exceeded all his predeceſſors. He alſo painted kitchens, &c. and gave dignity to ſubjects that ſeemed incapable of it. He was made painter to Ferdinand and Iſabella, archduke and ducheſs, and became attached to the houſe of the cardinal infant of Spain. The king of Spain and the elector Palatine adorned their palaces with huntings by this artiſt. Rubens, Jordaens, and Snyders, uſed to co-operate in the enriching of each other's pictures according to their ſeveral talents; and thus they became more valuable than if finiſhed by either of them ſingly. Snyders died in 1657.

SOAL-FISH. See PLEURONECTES, ICHTHYOLOGY *Index*.

SOAP, a compoſition of cauſtic, fixed alkaline ſalt, and oil, ſometimes hard and dry, ſometimes ſoft and liquid; much uſed in waſhing, whitening linens, and by dyers and fullers.—Soap may be made by ſeveral methods, which, however, all depend upon the ſame principle. The ſoap which is uſed in medicine is made without heat.

In manufactures where large quantities of it are prepared, ſoap is made with heat. A lixivium of quicklime and

and soda is made, but is less concentrated than that above referred to, and only so much that it can sustain a fresh egg. A part of this lixivium is to be even diluted and mixed with an equal weight of oil of olives. The mixture is to be put on a gentle fire, and agitated, that the union may be accelerated. When the mixture begins to unite well, the rest of the lixivium is to be added to it; and the whole is to be digested with a very gentle heat, till the soap be completely made. A trial is to be made of it, to examine whether the just proportion of oil and alkali has been observed. Good soap of this kind ought to be firm, and very white when cold; not subject to become moist by exposure to air, and entirely miscible with pure water, to which it communicates a milky appearance, but without any drops of oil floating on the surface. When the soap has not these qualities, the combination has not been well made, or the quantity of salt or oil is too great, which faults must be corrected.

In soft or liquid soaps, green or black soaps, cheaper oils are employed, as oil of nuts, of hemp, of fish, &c. These soaps, excepting in consistence, are not essentially different from white soap.

Fixed alkalies are much disposed to unite with oils that are not volatile, both vegetable and animal, since this union can be made even without heat. The compound resulting from this union partakes at the same time of the properties of oil and of alkali; but these properties are modified and tempered by each other, according to the general rule of combinations. Alkali formed into soap has not nearly the same acrimony as when it is pure; it is even deprived of almost all its causticity, and its other saline alkaline properties are almost entirely abolished. The same oil contained in soap is less combustible than when pure, from its union with the alkali, which is an uninflammable body. It is miscible, or even soluble, in water, to a certain degree, by means of the alkali. Soap is entirely soluble in spirit of wine; and still better in aquavitæ sharpened by a little alkaline salt, according to an observation of Mr Geoffroy.

The manufacture of soap in London first began in the year 1524; before which time this city was served with white soap from foreign countries, and with gray soap speckled with white from Bristol, which was sold for a penny a pound; and also with black soap, which sold for a halfpenny the pound.

The principal soaps of our own manufacture are the soft, the hard, and the ball soap. The soft soap is either white or green. The process of making each of these shall now be described.

Green soft soap. The chief ingredients used in making this are lees drawn from pot-ash and lime, boiled up with tallow and oil. First, the ley of a proper degree of strength (which must be estimated by the weight of the liquor), and tallow, are put into the copper together, and as soon as they boil up the oil is added; the fire is then damped or stopped up, while the ingredients remain in the copper to unite; when they are united, the copper is again made to boil, being fed or filled with lees as it boils, till there be a sufficient quantity put into it; then it is boiled off and put into casks. When this soap is first made it appears uniform; but in about a week's time the tallow separates from the oil into those white grains which we see in common soap. Soap thus made would appear yellow, but by a mixture of indigo added at the end of the boiling, it is rendered green, that being the colour which results from the mixture of yellow and blue.

White soap. Of this one sort is made after the same manner as green soft soap, oil alone excepted, which is not used in white. The other sort of white soft soap is made from the lees of ashes of lime boiled up two different times with tallow. First, a quantity of lees and tallow are put into the copper together, and kept boiling, being fed with lees as they boil, until the whole is boiled sufficiently; then the lees are separated or discharged from the tallowish part, which part is removed into a tub, and the lees are thrown away; this is called the *first half-boil:* then the copper is filled again with fresh tallow and lees, and the first half-boil is put out of the tub into the copper a second time, where it is kept boiling with fresh lees and tallow till the soap is produced. It is then put out of the copper into the same sort of casks as are used for green soft soap. The common soft soap used about London, generally of a greenish hue, with some white lumps, is prepared chiefly with tallow: a blackish sort, more common in some other places, is said to be made with whale oil.

Hard soap is made with lees from ashes and tallow, and is most commonly boiled twice: the first, called the *half-boil*, hath the same operation as the first half-boil of soft white soap. Then the copper is charged with fresh lees again, and the first half boil put into it, where it is kept boiling, and fed with lees as it boils, till it grains or is boiled enough: then the ley is discharged from it, and the soap put into a frame to cool and harden. Common salt is made use of for the purpose of graining the soap; for when the oil or tallow has been united with the ley, after a little boiling, a quantity of salt is thrown into the mass, which dissolving readily in water, but not in the oil or tallow, draws out the water in a considerable degree, so that the oil or tallow united with the salt of the ley swims on the top. When the ley is of a proper strength, less salt is necessary to raise the curd than when it is too weak. It must be observed, that there is no certain time for bringing off a boiling of any of these sorts of soap: it frequently takes up part of two days.

Ball soap, commonly used in the north, is made with lees from ashes and tallow. The lees are put into the copper, and boiled till the watery part is quite gone, and there remains nothing in the copper but a sort of saline matter (the very strength or essence of the ley); to this the tallow is put, and the copper is kept boiling and stirring for above half an hour, in which time the soap is made; and then it is put out of the copper into tubs or baskets with sheets in them, and immediately (whilst soft) made into balls. It requires near 24 hours in this process to boil away the watery part of the ley.

When oil unites with alkali in the formation of soap, it is little altered in the connection of its principles; for it may be separated from the alkali by decomposing soap with any acid, and may be obtained nearly in its original state.

Concerning the decomposition of soap by means of acids, we must observe, first, that all acids, even the weakest vegetable acids, may occasion this decomposition, because every one of them has a greater affinity than

than oil with fixed alkali. Secondly, these acids, even when united with any basis, excepting fixed alkali, are capable of occasioning the same decomposition; whence all ammoniacal salts, all salts with bases of earth, and all those with metallic bases, are capable of decomposing soap, in the same manner as disengaged acids are; with this difference, that the oil separated from the fixed alkali, by the acid of these salts, may unite more or less intimately with the substance which was the basis of the neutral salt employed for the decomposition.

Soap may also be decomposed by distillation, as Lemery has done. When first exposed to fire, it yields a phlegm called by him a *spirit;* which nevertheless is neither acid nor alkaline, but some water which enters into the composition of soap. It becomes more and more coloured and empyreumatic as the fire is increased, which shows that it contains the most subtle part of the oil. It seems even to raise along with it, by help of the oil and action of the fire, a small part of the alkali of the soap: for as the same chemist observes, it occasions a precipitate in a solution of corrosive sublimate. After this phlegm the oil rises altered, precisely as if it had been distilled from quicklime, that is, empyreumatic, soluble in spirit of wine, at first sufficiently subtle and afterwards thicker. An alkaline residuous coal remains in the retort, consisting chiefly of the mineral alkali contained in the soap, and which may be disengaged from the coal by calcination in an open fire, and obtained in its pure state.

Alkaline soaps are very useful in many arts and trades, and also in chemistry and medicine. Their principal utility consists in a detersive quality that they receive from their alkali, which, although it is in some measure saturated with oil, is yet capable of acting upon oily matters, and of rendering them saponaceous and miscible with water. Hence soap is very useful to cleanse any substances from all fat matters with which they happen to be soiled. Soap is therefore daily used for the washing and whitening of linen, for the cleansing of woollen-cloths from oil, and for whitening silk and freeing it from the resinous varnish with which it is naturally covered. Pure alkaline lixiviums being capable of dissolving oils more effectually than soap, might be employed for the same purposes; but when this activity is not mitigated by oil, as it is in soap, they are capable of altering, and even of destroying entirely by their causticity, most substances, especially animal matters, as silk, wool, and others: whereas soap cleanses from oil almost as effectually as pure alkali, without danger of altering or destroying; which renders it very useful.

Woodville's Medical Botany, p. 390.

Soap was imperfectly known to the ancients. It is mentioned by Pliny as made of fat and ashes, and as an invention of the Gauls. Aretæus and others informs us, that the Greeks obtained their knowledge of its medical use from the Romans. Its virtues, according to Bergius, are detergent, resolvent, and aperient, and its use recommended in jaundice, gout, calculous complaints, and in obstructions of the viscera. The efficacy of soap in the first of these diseases was experienced by Sylvius, and since recommended very generally by various authors who have written on this complaint; and it has also been thought of use in supplying the place of bile in the primæ viæ. The utility of this medicine in icterical cases was inferred chiefly from its supposed power of dissolving biliary concretions; but this medicine has lost much of its reputation in jaundice, since it is now known that gall-stones have been found in many after death who had been daily taking soap for several months and even years. Of its good effects in urinary calculous affections, we have the testimony of several, especially when dissolved in lime-water, by which its efficacy is considerably increased; for it thus becomes a powerful solvent of mucus, which an ingenious modern author supposes to be the chief agent in the formation of calculi; it is, however, only in the incipient state of the disease that these remedies promise effectual benefit; though they generally abate the more violent symptoms where they cannot remove the cause. With Boerhaave soap was a general medicine: for as he attributed most complaints to viscidity of the fluids, he, and most of the Boerhaavian school, prescribed it in conjunction with different resinous and other substances, in gout, rheumatism, and various visceral complaints. Soap is also externally employed as a resolvent, and gives name to several officinal preparations.

From the properties of soap we may know that it must be a very effectual and convenient anti-acid. It absorbs acids as powerfully as pure alkalies and absorbent earths, without having the causticity of the former, and without oppressing the stomach by its weight like the latter.

Lastly, we may perceive that soap must be one of the best of all antidotes to stop quickly, and with the least inconvenience, the bad effects of acid corrosive poisons, as aquafortis, corrosive sublimate, &c.

Soap imported is subject by 10 Ann. cap. 19. to a duty of 2d. a pound (over and above former duties); and by 12 Ann. stat. 2. cap. 9. to the farther sum of 1d. a pound. And by the same acts, the duty on soap made in the kingdom is 1½d. a pound. By 19 G. III. cap. 52. no person within the limits of the head office of excise in London shall be permitted to make any soap unless he occupy a tenement of 10l. a year, be assessed, and pay the parish rates; or elsewhere, unless he be assessed, and pay to church and poor. Places of making are to be entered on pain of 50l. and covers and locks to be provided under a forfeiture of 100l.; the furnace-door of every utensil used in the manufacture of soap shall be locked by the excise officer, as soon as the fire is damped or drawn out, and fastenings provided, under the penalty of 50l.; and opening or damaging such fastening incurs a penalty of 100l. Officers are required to enter and survey at all times, by day or night, and the penalty of obstructing is 20l.; and they may unlock and examine every copper, &c. between the hours of five in the morning and eleven in the evening, and the penalty of obstructing is 100l. Every maker of soap before he begins any making, if within the bills of mortality, shall give 12 hours, if elsewhere 24 hours, notice in writing to the officer, of the time when he intends to begin, on pain of 50l. No maker shall remove any soap unsurveyed on pain of 20l. without giving proper notice of his intention. And if any maker shall conceal any soap or materials, he shall forfeit the same, and also 500l. Every barrel of soap shall contain 256 lb. avoirdupois, half barrel 128 lb. firkin 64 lb. half-firkin 32 lb. besides the weight or tare of each cask: and all soap, excepting hard cake soap and ball soap, shall be put into such casks and no other, on pain of forfeiture, and 5l. The maker shall weekly

Soap ‖ Society.

weekly enter in writing at the next office the ſoap made by him in each week, with the weight and quantity at each boiling, on pain of 50l.; and within one week after entry clear off the duties, on pain of double duty. See, beſides the ſtatutes above cited, 5 Geo. III. cap. 43. 12 Geo III. cap. 46. 11 Geo. cap. 30. 1 Geo. ſtat. 2. cap. 36.

Acid SOAP. This is formed by the addition of concentrated acids to the expreſſed oils. Thus the oil is rendered partially ſoluble in water; but the union is not ſufficiently complete to anſwer any valuable purpoſe.

SOAP-Berry Tree. See SAPINDUS, BOTANY *Index.*

SOAP-Earth. See STEATITES, MINERALOGY *Index.*

SOAPWORT. See SAPONARIA, BOTANY *Index.*

SOC (Sax.), ſignifies power or liberty to miniſter juſtice or execute laws; alſo the circuit or territory wherein ſuch power is exerciſed. Whence our law-Latin word *ſocca* is uſed for a ſeigniory or lordſhip enfranchiſed by the king, with the liberty of holding or keeping a court of his *ſockmen*: And this kind of liberty continues in divers parts of England to this day, and is known by the names of *ſoke* and *ſoken.*

SOCAGE, in its moſt general and extenſive ſignification, ſeems to denote a tenure by any certain and determinate ſervice. And in this ſenſe it is by our ancient writers conſtantly put in oppoſition to chivalry or knight-ſervice, where the render was precarious and uncertain. The ſervice muſt therefore be certain, in order to denominate it ſocage; as to hold by fealty and 20s. rent; or, by homage, fealty, and 20s. rent; or, by homage and fealty without rent; or, by fealty and certain corporal ſervice, as ploughing the lord's land for three days; or, by fealty only without any other ſervice: for all theſe are tenures in ſocage.

Blackſt. Comment. vol. ii.

Socage is of two ſorts: *free*-ſocage, where the ſervices are not only certain but honourable; and *villein*-ſocage, where the ſervices, though certain, are of a baſer nature (ſee VILLENAGE). Such as hold by the former tenure are called, in Glanvil and other ſubſequent authors, by the name of *liberi ſokemanni*, or tenants in free-ſocage. The word is derived from the Saxon appellation *ſoc*, which ſignifies liberty or privilege; and, being joined to an uſual termination, is called *ſocage*, in Latin *ſocagium;* ſignifying thereby a free or privileged tenure.

It ſeems probable that the ſocage-tenures were the relics of Saxon liberty; retained by ſuch perſons as had neither forfeited them to the king, nor been obliged to exchange their tenure for the more honourable, as it was called, but at the ſame time more burthenſome, tenure of knight-ſervice. This is peculiarly remarkable in the tenure which prevails in Kent, called *gavelkind*, which is generally acknowledged to be a ſpecies of ſocage-tenure; the preſervation whereof inviolate from the innovations of the Norman conquerer is a fact univerſally known. And thoſe who thus preſerved their liberties were ſaid to hold in free and common ſocage.

As therefore the grand criterion and diſtinguiſhing mark of this ſpecies of tenure are the having its renders or ſervices aſcertained, it will include under it all other methods of holding free lands by certain and invariable rents and duties; and in particular, *Petit SERJEANTY, Tenure in BURGAGE*, and GAVELKIND. See theſe articles.

1 Definition.

SOCIETY, a number of rational and moral beings, united for their common preſervation and happineſs.

2 How far brutes are capable of a ſocial ſtate.

There are ſhoals of fiſhes, herds of quadrupeds, and flocks of birds. But till obſervation enable us to determine with greater certainty, how far the inferior animals are able to look through a ſeries of means to the end which theſe are calculated to produce, how far their conduct may be influenced by the hope of reward and the fear of puniſhment, and whether they are at all capable of moral diſtinctions—we cannot with propriety apply to them the term *Society.* We call crows and beavers, and ſeveral other ſpecies of animals, *gregarious;* but it is hardly good Engliſh to ſay that they are *ſocial.*

3 Mankind the only ſocial beings ſubject to our obſervation.

It is only human ſociety, then, that can become the ſubject of our preſent inveſtigation. The phenomena which it preſents are highly worthy of our notice.

4 A ſocial and a ſavage ſtate.

Such are the advantages which each individual evidently derives from living in a ſocial ſtate; and ſo helpleſs does any human being appear in a ſolitary ſtate, that we are naturally led to conclude, that if there ever was a period at which mankind were ſolitary beings, that period could not be of long duration; for their averſion to ſolitude and love of ſociety would ſoon induce them to enter into ſocial union. Such is the opinion which we are led to conceive, when we compare our own condition as members of civilized and enlightened ſociety with that of the brutes around us, or with that of ſavages in the earlier and ruder periods of ſocial life. When we hear of Indians wandering naked through the woods, deſtitute of arts, unſkilled in agriculture, ſcarce capable of moral diſtinctions, void of all religious ſentiments, or poſſeſſed with the moſt abſurd notions concerning ſuperior powers, and procuring means of ſubſiſtence in a manner equally precarious with that of the beaſts of prey—we look down with pity on their condition, or turn from it with horror. When we view the order of cultivated ſociety, and conſider our inſtitutions, arts, and manners—we rejoice over our ſuperior wiſdom and happineſs.

Man in a civilized ſtate appears a being of a ſuperior order to man in a ſavage ſtate; yet ſome philoſophers tell us, that it is only he who, having been educated in ſociety, has been taught to depend upon others, that can be helpleſs or miſerable when placed in a ſolitary ſtate. They view the ſavage who exerts himſelf with intrepidity to ſupply his wants, or bears them with fortitude, as the greateſt hero, and poſſeſſing the greateſt happineſs. And therefore if we agree with them, that the propenſities of nature may have prompted men to enter into ſocial union, though they may have hoped to enjoy ſuperior ſecurity and happineſs by engaging to protect and ſupport each other, we muſt conclude that the Author of the univerſe has deſtined man to attain greater dignity and happineſs in a ſavage and ſolitary than in a ſocial ſtate; and therefore that thoſe diſpoſitions and views which lead us to ſociety are fallacious and inimical to our real intereſt.

Whatever be the ſuppoſed advantages of a ſolitary ſtate, certain it is that mankind, at the earlieſt periods, were united in ſociety. Various theories have been formed concerning the circumſtances and principles which gave riſe to this union: but we have elſewhere ſhown, that the greater part of them are founded in error; that they ſuppoſe the original ſtate of man to have been

been that of ſavages; and that ſuch a ſuppoſition is contradicted by the moſt authentic records of antiquity. For though the records of the earlier ages are generally obſcure, fabulous, and imperfect; yet happily there is *one* free from the imperfections of the reſt, and of undoubted authenticity, to which we may ſafely have recourſe *. This record is the Pentateuch of Moſes, which preſents us with a genuine account of the origin of man and of ſociety, perfectly conſonant to what we have laid down in the article referred to (ſee SAVAGE).

* See *Scripture*, N° 7—12.

5 First ſtate of ſociety according to authentic hiſtory.

According to Moſes, the firſt ſociety was that of a huſband and wife united in the bonds of marriage: the firſt government that of a father and huſband, the maſter of his family. Men lived together under the patriarchal form of government while they employed themſelves chiefly in tending flocks and herds. Children in ſuch circumſtances cannot ſoon riſe to an equality with their parents, where a man's importance depends on his property, not on his abilities. When flocks and herds are the chief articles of property, the ſon can only obtain theſe from his father; in general therefore the ſon muſt be entirely dependent on the father for the means of ſubſiſtence. If the parent during his life beſtow on his children any part of his property, he may do it on ſuch conditions as ſhall make their dependence upon him continue till the period of his death. When the community are by this event deprived of their head, inſtead of continuing in a ſtate of union, and ſelecting ſome one from among themſelves whom they may inveſt with the authority of a parent, they ſeparate into ſo many diſtinct tribes, each ſubjected to the authority of a different lord, the maſter of the family, and the proprietor of all the flocks and herds belonging to it. Such was the ſtate of the firſt ſocieties which the narrative of Moſes exhibits to our attention.

6 Theories of philoſophers concerning the origin of ſociety

Thoſe philoſophers who have made ſociety, in its various ſtages between rudeneſs and refinement, the ſubject of their ſpeculations, have generally conſidered mankind, in whatever region of the globe, and under whatever climate, as proceeding uniformly through certain regular gradations from one extreme to the other. They regard them, firſt, as gaining a precarious ſubſiſtence by gathering the ſpontaneous fruits of the earth, preying on the inhabitants of the waters, if placed on the ſea-ſhore, or along the banks of large rivers; or hunting wild beaſts, if in a ſituation where theſe are to be found in abundance; without foreſight or induſtry to provide for future wants when the preſent call of appetite is gratified. Next, they ſay, man riſes to the ſhepherd ſtate, and next to that of huſbandmen, when they turn their attention from the management of flocks to the cultivation of the ground. Next, theſe huſbandmen improve their powers, and better their condition, by becoming artizans and merchants; and the beginning of this period is the boundary between barbarity and civilization.

Theſe are the ſtages through which they who have employed themſelves on the natural hiſtory of ſociety have generally conducted mankind in their progreſs from rudeneſs to refinement: but they ſeem to have overlooked the manner in which mankind were at firſt eſtabliſhed on this earth; for the circumſtances in which the parents of the human race were originally placed; for the degree of knowledge communicated to them; and for the inſtruction which they muſt have been capable of communicating to their poſterity. They rather appear to conſider the inhabitants of every different region of the globe as aborigines, ſpringing at firſt from the ground, or dropped on the ſpot which they inhabit; no leſs ignorant than infants of the nature and relations of the objects around them, and of the purpoſes which they may accompliſh by the exerciſe of their organs and faculties.

7 are fanciful.

The abſurdity of this theory has been fully demonſtrated in another place: and if we agree to receive the Moſaic account of the original eſtabliſhment of mankind, we ſhall be led to view the phenomena of ſocial life in a light very different. We muſt firſt allow, that though many of the rudeſt tribes are found in the ſtate of *hunters* or *fiſhers*; yet the hunting or fiſhing ſtate cannot have been invariably the primary form of ſociety. Notwithſtanding the powers with which we are endowed, we are in a great meaſure the creatures of circumſtances. Phyſical cauſes exert, though indirectly, a mighty influence in forming the character and directing the exertions of the human race. From the information of Moſes we gather, that the firſt ſocieties of men lived under the patriarchal form of government, and employed themſelves in the cultivation of the ground and the management of flocks. And as we know that mankind, being ſubjected to the influence both of phyſical and moral cauſes, are no leſs liable to degeneracy than capable of improvement; we may eaſily conceive, that though deſcending all from the ſame original pair, and though enlightened with much traditionary knowledge relative to the arts of life, the order of ſociety, moral diſtinctions, and religious obligations; yet as they were gradually, and by various accidents, diſperſed over the earth, being removed to ſituations in which the arts with which they were acquainted could but little avail them, where induſtry was overpowered, or indolence encouraged by the ſeverity or the profuſion of nature, they might degenerate and fall into a condition almoſt as humble and precarious as that of the brutal tribes. Other moral cauſes might alſo concur to debaſe or elevate the human character in that early period. The particular character of the original ſettlers in any region, the manner in which they were connected with one another, and the arts which they were beſt qualified to exerciſe, with various other cauſes of a ſimilar nature, would have conſiderable influence in determining the character of the ſociety.

When laying aſide the ſpirit of theory and ſyſtem, we ſet ourſelves, with due humility, to trace facts, and to liſten to evidence, though our diſcoveries may be fewer than we ſhould otherwiſe fancy them; yet the knowledge which we thus acquire will be more uſeful and ſolid, and our ſpeculations more conſiſtent with the ſpirit of true philoſophy. Here, though we learn from the information of the ſacred writings, that the firſt family of mankind was not cruelly expoſed in this world, as children whom the inhumanity of their parents induces them to deſert; yet we are not, in conſequence of admitting this fact, laid under any neceſſity of denying or explaining away any of the other phenomena which occur to our obſervation when tracing the natural hiſtory of ſociety. Tradition may be corrupted; arts and ſciences may be loſt; the ſublimeſt religious doctrines may be debaſed into abſurdity.

If then we are deſirous of ſurveying ſociety in its rudeſt

Society. deſt form, we muſt look, not to the earlieſt period of its exiſtence, but to thoſe diſtricts of the globe where external circumſtances concur to drive them into a ſtate of ſtupidity and wretchedneſs. Thus in many places of the happy clime of Aſia, which a variety of ancient records concur with the ſacred writings in repreſenting as the firſt peopled quarter of the globe, we cannot trace the form of ſociety backwards beyond the ſhepherd ſtate. In that ſtate indeed the bonds which connect ſociety extend not to a wide range of individuals, and men remain for a long period in diſtinct families; but yet that ſtate is highly favourable to knowledge, to happineſs, and to

8

Yet in ſome particular inſtances realized.

virtue. Again, the torrid and the frozen regions of the earth, though probably peopled at a later period, and by tribes ſprung from the ſame ſtock with the ſhepherds of Aſia, have yet exhibited mankind in a much lower ſtate. It is in the parched deſerts of Africa and the wilds of America that human beings have been found in a condition approaching the neareſt to that of the brutes.

We may therefore with ſome propriety deſert the order of time, and take a view of the different ſtages through which philoſophers have conſidered mankind as advancing, beginning with that of rudeneſs, though we have ſhown that it cannot have been the firſt in the progreſs.

9

Rudeſt ſtate or firſt ſtage of ſociety.

Where the human ſpecies are found in the loweſt and rudeſt ſtate, their rational and moral powers are very faintly diſplayed; but their external ſenſes are acute, and their bodily organs active and vigorous. Hunting and fiſhing are then their chief employments on which they depend for ſupport. During that portion of their time which is not ſpent in theſe purſuits, they are ſunk in liſtleſs indolence. Deſtitute of foreſight, they are rouſed to active exertion only by the preſſure of immediate neceſſity or the urgent calls of appetite. Accuſtomed to endure the ſeverity of the elements, and but ſcantily provided with the means of ſubſiſtence, they acquire habits of reſignation and fortitude, which are beheld with aſtoniſhment by thoſe who enjoy the plenty and indulgence of cultivated life. But in this ſtate of want and depreſſion, when the powers and poſſeſſions of every individual are ſcarcely ſufficient for his own ſupport, when even the calls of appetite are repreſſed becauſe they cannot always be gratified, and the more refined paſſions, which either originate from ſuch as are merely animal, or are intimately connected with them, have not yet been felt—in this ſtate all the milder affections are unknown; or if the breaſt is at all ſenſible to their impulſe, it is extremely feeble. Huſband and wife, parent and child, brother and brother, are united by the weakeſt ties. Want and misfortune are not pitied. Why indeed ſhould they, where they cannot be relieved? It is impoſſible to determine how far beings in this condition can be capable of moral diſtinctions. One thing certain is, that in no ſtate are the human race entirely incapable of theſe. If we liſten, however, to the relations of reſpectable travellers, we muſt admit that human beings have ſometimes been found in that abject ſtate where no proper ideas of ſubordination, government, or diſtinction of ranks, could be formed. No diſtinct notions of Deity can be here entertained. Beings in ſo humble a condition cannot look through the order of the univerſe and the harmony of nature to that Eternal Wiſdom and Goodneſs which contrived, and that Almighty Power which brought into exiſtence, the ſyſtem of things. Of arts they muſt be almoſt totally deſtitute. They may uſe ſome inſtruments for fiſhing or the chace; but theſe muſt be extremely rude and ſimple. If they be acquainted with any means to ſhelter them from the inclemency of the elements, both their houſes and clothing will be aukward and inconvenient. Society.

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Social ſtate in the ſecond ſtage of ſociety.

But human beings have not been often found in ſo rude a ſtate as this. Even thoſe tribes which we denominate ſavage, are for the moſt part farther removed from mere animal life. They generally appear united under ſome ſpecies of government, exerciſing the powers of reaſon, capable of morality, though that morality be not always very refined; diſplaying ſome degree of ſocial virtues, and acting under the influence of religious ſentiments. Thoſe who may be conſidered as but one degree higher in the ſcale than the ſtupid and wretched beings whoſe condition we have ſurveyed, are to be found ſtill in the hunting and fiſhing ſtate; but they are farther advanced towards ſocial life, and are become more ſenſible to the impulſe of ſocial affection. By unavoidable intercourſe in their employments, a few individual hunters or fiſhers contract a certain degree of fondneſs for each other's company, and are led to take ſome part in each other's joys and ſorrows; and when the ſocial affections thus generated (ſee PASSION) begin to exert themſelves, all the other powers of the mind are at the ſame time called forth, and the circumſtances of the little ſociety are immediately improved. We behold its members in a more comfortable condition, and find reaſon to view the human character with more complacency and reſpect. Huts are now built, more commodious clothes are faſhioned, inſtruments for the annoyance of wild beaſts and even of enemies are contrived, in ſhort, arts, and ſcience, and ſocial order, and religious ſentiment, and ceremonies, now make their appearance in the riſing ſociety, and ſerve to characterize it by the particular form which diſtinguiſhes each of them. But though ſocial order is no longer unknown nor unobſerved, yet the form of government is ſtill extremely ſimple, and its ties are but looſe and feeble. It will perhaps bear ſome reſemblance to the patriarchal; only all its members are on a more equal footing, and and at the ſame time leſs cloſely connected than in the ſhepherd ſtate, to which that form of government ſeems almoſt peculiar. The old men are treated with veneration; but the young are not entirely ſubject to them. They may liſten reſpectfully to their advice; but they do not ſubmit to their arbitrary commands. Where mankind are in the ſtate of hunters and fiſhers, where the means of ſubſiſtence are precariouſly acquired, and prudent foreſight does not prompt to accumulate much proviſion for the future, no individual can acquire comparative wealth. As ſoon as the ſon is grown up, he ceaſes to be dependent on his father, as well as on the ſociety in general. Difference of experience therefore conſtitutes the only diſtinction between the young and the old; and if the old have experience, the young have ſtrength and activity. Here, then, neither age nor property can give riſe to any ſtriking diſtinction of ranks. All who have attained to manhood, and are not diſabled by unuſual deficiency of ſtrength or agility, or by the infirmities of old age, are on an equal footing; or if any one poſſeſs a pre-eminence over the reſt, he owes it to

ſuperior

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fuperior addrefs or fortitude. The whole tribe deliberate; the old give their advice; each individual of the affembly receives or rejects it at his pleafure (for the whole body think not of exercifing any compulfatory power over the will of individuals); and the warrior who is moft diftinguifhed for ftrength, addrefs, and valour, leads out the youth of the tribe to the chace or againft the enemy. War, which in the former ftage did not prevail, as they who were ftrangers to focial fentiments were, at the fame time, fcarce capable of being enemies, now firft begins to depopulate the thinly inhabited regions where thofe hunters and fifhers purfue their prey. They are fcattered, poffibly in fcanty and feparate tribes, over an immenfe tract of country; but they know no medium between the affection which brethren of the fame tribe bear to each other and the hatred of enemies. Though thinly fcattered over the earth, yet the hunting parties of different tribes will fometimes meet as they range the forefts; and when they meet, they will naturally view each other with a jealous eye; for the fuccefs of the one party in the chace may caufe the other to be unfuccefsful; and while the one fnatches the prey, the other muft return home to all the pangs of famine. Inveterate hoftility will therefore long prevail among neighbouring tribes in the hunting ftate.

If we find them not incapable of focial order, we may naturally expect that their conduct will be influenced by fome fentiments of religion. They have at this period ideas of fuperior beings. They alfo practife certain ceremonies to recommend them to thofe beings; but both their fentiments and ceremonies are fuperftitious and abfurd.

We have elfewhere fhown (fee POLYTHEISM) how favage tribes have probably degenerated from the pure worfhip of the one true God to the adoration of a multitude of imaginary divinities in heaven, earth, and hell. We have traced this idolatrous worfhip from that of the heavenly bodies, through all the gradations of dæmon-worfhip, hero-worfhip, and ftatue-worfhip, to that wonderful inftance of abfurd fuperftition which induced the inhabitants of fome countries to fall proftrate in adoration before the vileft reptiles. But though we are convinced that the heavenly bodies have by all idolaters been confidered as their firft and greateft gods, we pretend not that the progrefs through the other ftages of polytheifm has been everywhere in the very fame order. It is indeed impoffible to exhibit under one general view an account of arts, manners, and religious fentiments, which may apply to fome certain period in the hiftory of every nation. The characters and circumftances of nations are fcarce lefs various and anomalous than thofe of individuals. Among many of the American tribes, among the ancient inhabitants of the forefts of Germany, whofe manners have been fo accurately delineated by the mafterly pen of Tacitus, and in fome of the iflands fcattered over the fouthern ocean, religion, arts, and government, have been found in that ftate which we have defcribed as characterifing the fecond ftage of focial life. But neither can we pretend that all thofe fimple and rude focieties have been defcribed by hiftorians and travellers as agreeing precifely in their arts, manners, and religious fentiments; or that the difference of circumftances always enables us to account in a fatisfactory manner for the diftinction of their characters. There is a variety of facts in the hiftory of the early periods of fociety, which no ingenuity, no induftry however painful, can reduce under general heads. Here, as well as when we attempt to philofophize on the phenomena of the material world, we find reafon to confefs that our powers are weak, and our obfervation confined within a narrow fphere.

II
Third ftage in the progrefs of fociety, in which ideas of property and inequality of ranks appear.

But we may now carry our views a little forward, and furvey human life as approaching fomewhat nearer to a civilized and enlightened ftate. As property is acquired, inequality and fubordination of ranks neceffarily follow: and when men are no longer equal, the many are foon fubjected to the will of the few. But what gives rife to thefe new phenomena is, that after having often fuffered from the precarioufnefs of the hunting and fifhing ftate, men begin to extend their cares beyond the prefent moment, and to think of providing fome fupply for future wants. When they are enabled to provide fuch a fupply, either by purfuing the chace with new eagernefs and perfeverance, by gathering the fpontaneous fruits of the earth, or by breeding tame animals—thefe acquifitions are at firft the property of the whole fociety, and diftributed from a common ftore to each individual according to his wants: But as various reafons will foon concur to convince the community, that by this mode of diftribution, induftry and activity are treated with injuftice, while negligence and indolence receive more than their due, each individual will in a fhort time become his own fteward, and a community of goods will be abolifhed. As foon as diftinct ideas of property are formed, it muft be unequally diftributed; and as foon as property is unequally diftributed, there arifes an inequality of ranks. Here we have the origin of the depreffion of the female fex in rude ages, of the tyrannical authority exercifed by parents over their children, and perhaps of flavery. The women cannot difplay the fame perfeverance, or activity, or addrefs, as the men, in purfuing the chace. They are therefore left at home; and from that moment are no longer equals, but flaves and dependants, who muft fubfift by the bounty of the males, and muft therefore fubmit with implicit obedience to all their capricious commands. Even before the era of property, the female fex were viewed as inferiors; but till that period they were not reduced to a ftate of abject flavery.

In this period of fociety new notions are formed of the relative duties. Men now become citizens, mafters, and fervants; hufbands, parents, &c. It is impoffible to enumerate all the various modes of government which take place among the tribes who have advanced to this ftage; but one thing certain is, that the authority of the few over the many is now firft eftablifhed, and that the rife of property firft introduces inequality of ranks. In one place, we fhall perhaps find the community fubjected during this period to the will of a fingle perfon; in another, power may be lodged in the hands of a number of chiefs; and in a third, every individual may have a voice in creating public officers, and in enacting laws for the fupport of public order. But as no code of laws is formed during this period, juftice is not very impartially adminiftered, nor are the rights of individuals very faithfully guarded. Many actions, which will afterwards be confidered as heinoufly immoral, are now confidered as praife-worthy or indifferent. This is the age of hero-worfhip, and of houfehold and tutelary gods; for

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for it is in this stage of society that the invention of arts, which gave rise to that worship, contributes most conspicuously to the public good. War, too, which we considered as beginning first to ravage the earth during the former period, and which is another cause of the deification of dead men, will still prevail in this age, and be carried on with no less ferocity than before, though in a more systematic form.

The prevalence of war, and the means by which subsistence is procured, cannot but have considerable influence on the character and sentiments of societies and individuals. The hunter and the warrior are characters in many respects different from the shepherd and the husbandman. Such, in point of government, arts, and manners, religious and moral sentiments, were several of the German tribes described by Tacitus; and the Britons whose character has been sketched by the pen of Cæsar: such, too, were the Romans in the early period of their history; such too the inhabitants of Asia Minor about the time of the siege of Troy, as well as the Greeks whom Homer celebrates as the destroyers of the Trojan state: the northern tribes also, who poured through Asia, Africa, and Europe, and overthrew the Roman empire, appear to have been of a nearly similar character. It seems to be a general opinion among those who have directed their attention to the history of society, that, in the scale ascending from the lowest condition of human beings to the most civilized and enlightened state of society, the shepherd state is the next in order above the hunting; and that as mankind improve in knowledge and in moral sentiments, and as the forests are gradually depopulated of their inhabitants, instead of destroying the inferior animals, men become their guardians and protectors. But we cannot unreservedly subscribe to this opinion: we believe, that in the shepherd state societies have been sometimes found superior to the most polished tribes of hunters; but upon viewing the annals of mankind in early ages, we observe that there is often no inconsiderable resemblance even between hunters and shepherds in point of the improvement of the rational faculties and the moral sense; and we are therefore led to think, that these two states are sometimes parallel: for instance, several of the American tribes, who still procure their subsistence by hunting, appear to be nearly in the state which we have described as the third stage in the progress of society; and the ancient shepherds of Asia do not appear to have been much more cultivated and refined. We even believe that men have sometimes turned their attention from hunting to agriculture, without passing through any intermediate state. Let us remember, that much depends upon local circumstances, and somewhat undoubtedly on original inspiration and traditionary instruction. In this period of society the state of the arts well deserves our attention. We shall find, that the shepherds and the hunters are in that respect on a pretty equal footing. Whether we examine the records of ancient history, or view the islands scattered through the South sea, or range the wilds of America, or survey the snowy wastes of Lapland and the frozen coast of Greenland—still we find the useful arts in this period, though known and cultivated, in a very rude state; and the fine arts, or such as are cultivated merely to please the fancy or to gratify caprice, displaying an odd and fantastic, not a true or natural, taste; yet this is the period in which eloquence shines with the truest lustre: all is metaphor or glowing sentiment. Languages are not yet copious; and therefore speech is figurative, expressive, and forcible. The tones and gestures of nature, not being yet laid aside, as they generally are, from regard to decorum, in more polished ages, give a degree of force and expression to the harangues of the rustic or savage orator, which the most laborious study of the rules of rhetoric and elocution could not enable even a more polished orator to display.

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Fourth stage; in which agriculture flourishes, the arts are subdivided, commerce and regular government are introduced.

But let us advance a little farther, and contemplate our species in a new light, where they will appear with greater dignity and amiableness of character. Let us view them as husbandmen, artizans, and legislators. Whatever circumstances might turn the attention of any people from hunting to agriculture, or cause the herdsman to yoke his oxen for the cultivation of the ground, certain it is that this change in the occupation would produce a happy change on the character and circumstances of men; it would oblige them to exert a more regular and persevering industry. The hunter is like one of those birds that are described as passing the winter in a torpid state. The shepherd's life is extremely indolent. Neither of these is very favourable to refinement. But different is the condition of the husbandman. His labours succeed each other in regular rotation through the year. Each season with him has its proper employments: he therefore must exert active persevering industry; and in this state we often find the virtues of rude and polished ages united. This is the period where barbarism ends and civilization begins. Nations have existed for ages in the hunting or the shepherd state, fixed as by a kind of stagnation, without advancing farther. But scarcely any instances occur in the history of mankind of those who once reached the state of husbandmen, remaining long in that condition without rising to a more civilized and polished state. Where a people turn their attention in any considerable degree to the objects of agriculture, a distinction of occupations naturally arises among them. The husbandman is so closely employed through the several seasons of the year in the labours of the field, that he has no longer leisure to exercise all the rude arts known among his countrymen. He has not time to fashion the instruments of husbandry, to prepare his clothes, to build his house, to manufacture household utensils, or to tend those tame animals which he continues to rear. Those different departments therefore now begin to employ different persons; each of whom dedicates his whole time and attention to his own occupation. The manufacture of cloth is for a considerable time managed exclusively by the women; but smiths and joiners arise from among the men. Metals begin now to be considered as valuable materials. The intercourse of mankind is now placed on a new footing. Before, every individual practised all the arts that were known, as far as was necessary for supplying himself with the conveniences of life. Now he confines himself to one or to a few of them; and, in order to obtain a necessary supply of the productions of those arts which he does not cultivate himself, he gives in exchange a part of the productions of his own labours. Here we have the origin of commerce.

After continuing perhaps for some time in this state, as arts and distinctions multiply in society, the exchange

change of one commodity for another is found troubleſome and inconvenient. It is ingeniouſly contrived to adopt a medium of commerce, which being eſtimated not by its intrinſic value, but by a certain nominal value which it receives from the agreement of the ſociety among whom it is uſed, ſerves to render the exchange of property, which is ſo neceſſary for the purpoſes of ſocial life, eaſy and expeditious. Wherever metals have been known, they appear to have been adopted as the medium of commerce almoſt as ſoon as ſuch a medium began to be uſed: and this is one important purpoſe for which they ſerve; but they have ſtill more important uſes. Almoſt all the neceſſary arts depend on them. Where the metals are known, agriculture practiſed, and the neceſſary arts diſtributed among different orders of artiſans—civilization and refinement, if not obſtructed by ſome accidental circumſtances, advance with a rapid progreſs. With regard to the firſt applying of the precious metals as the medium of commerce, we may obſerve, that this was probably not accompliſhed by means of a formal contract. They might be firſt uſed as ornaments; and the love of ornament, which prevails among rude as much as among civilized nations, would render every one willing to receive them in exchange for ſuch articles as he could ſpare. Such might be the change produced on ſociety with regard to the neceſſary arts by the origin of agriculture. As ſoon as ornament and amuſement are thought of, the fine arts begin to be cultivated. In their origin therefore they are not long poſterior to the neceſſary and uſeful arts. They appear long before men reach the comfortable and reſpectable condition of huſbandmen; but ſo rude is their character at their firſt origin, that our *Dilettanti* would probably view the productions of that period with unſpeakable contempt and diſguſt. But in the period of ſociety which we now conſider, they have aſpired to a higher character; yet poetry is now perhaps leſs generally cultivated than during the ſhepherd ſtate. Agriculture, conſidered by itſelf, is not directly favourable either to refinement of manners or to the fine arts. The converſation of ſhepherds is generally ſuppoſed to be far more elegant than than of huſbandmen; but though the direct and immediate effects of this condition of life be not favourable to the fine arts, yet indirectly it has a ſtrong tendency to promote their improvement. Its immediate influence is extremely favourable to the neceſſary and uſeful arts; and theſe are no leſs favourable to the fine arts.

One of the nobleſt changes which the introduction of the arts by agriculture produces on the form and circumſtances of ſociety, is the introduction of regular government and laws. In tracing the hiſtory of ancient nations, we ſcarcely ever find laws introduced at an earlier period. Minos, Solon, and Lycurgus, do not appear to have formed codes of wiſdom and juſtice for regulating the manners of their countrymen, till after the Cretans, the Athenians, and even the Lacedemonians, had made ſome progreſs in agriculture and the uſeful arts.

Religion, under all its various forms, has in every ſtage of ſociety a mighty influence on the ſentiments and conduct of men (ſee RELIGION); and the arts cultivated in ſociety have on the other hand ſome influence on the ſyſtem of religious belief. One happy effect which will reſult from the invention of arts, though perhaps not immediately, will be, to render the character of the deities more benevolent and amiable, and the rites of their worſhip more mild and humane.

The female ſex in this period generally find the yoke of their ſlavery ſomewhat lightened. Men now become eaſier in their circumſtances; the ſocial affections aſſume ſtronger influence over the mind; plenty, and ſecurity, and eaſe, at once communicate both delicacy and keenneſs to the ſenſual deſires. All theſe circumſtances concur to make men relax in ſome degree that tyrannic ſway by which they before depreſſed the ſofter ſex. The foundation of that empire, where beauty triumphs over both wiſdom and ſtrength, now begins to be laid. Such are the effects which hiſtory warrants as to attribute to agriculture and the arts; and ſuch the outlines of the character of that which we reckon the fourth ſtage in the progreſs of ſociety from rudeneſs to refinement.

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Fifth ſtage in the progreſs of ſociety; in which literature, arts, and ſciences, are much cultivated, and religion aſſumes a mild and engaging aſpect.

Let us advance one ſtep farther. We have not yet ſurveyed mankind in their moſt poliſhed and cultivated ſtate. Society is rude at the period when the arts firſt begin to ſhow themſelves, in compariſon of that ſtate to which it is raiſed by the induſtrious cultivation of them. The neighbouring commonwealths of Athens and Lacedemon afford us a happy opportunity of comparing this with the former ſtage in the progreſs of ſociety. The chief effect produced by the inſtitutions of Lycurgus ſeems to have been, to fix the manners of his countrymen for a conſiderable period in that ſtate to which they had attained in his days. Spartan virtue has been admired and extolled in the language of enthuſiaſm; but in the ſame manner has the character and the condition of the ſavage inhabitants of the wilds of America, been preferred by ſome philoſophers, to the virtues and the enjoyments of ſocial life in the moſt poliſhed and enlightened ſtate. The Spartans in the days of Lycurgus had begun to cultivate the ground, and were not unacquainted with the uſeful arts. They muſt ſoon have advanced farther had not Lycurgus ariſen, and by effecting the eſtabliſhment of a code of laws, the tendency of which appears to have been in many particulars directly oppoſite to the deſigns of nature, retarded their progreſs towards complete civilization and refinement. The hiſtory of the Lacedemonians, therefore, while the laws of Lycurgus continued in force, exhibits the manners and character of a people in that which we have denominated the fourth ſtage in the progreſs of ſociety. But if we turn our eyes to their neighbours the Athenians, we behold in their hiſtory the natural progreſs of opinions, arts, and manners. The uſeful arts are firſt cultivated with ſuch ſteady induſtry, as to raiſe the community to opulence, and to furniſh them with articles for commerce with foreign nations. The uſeful arts cannot be raiſed to this height of improvement without leading men to the purſuit of ſcience. Commerce with foreign nations, ſkill in the uſeful arts, and a taſte for ſcience, mutually aid each other, and conſpire to promote the improvement of the fine arts. Hence magnificent buildings, noble ſtatues, paintings expreſſive of life, action, and paſſion; and poems in which imagination adds new grace and ſublimity to nature, and gives the appearances of ſocial life more irreſiſtible power over the affections of the heart. Hence are moral diſtinctions more carefully ſtudied, and the

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Accordingly, when we view the state of literature in this period (for it is now become an object of so much importance as to force itself on our attention), we perceive that poetry, history, and morals, are the branches chiefly cultivated. Arts are generally casual inventions, and long practised before rules and principles on which they are founded assume the form of science. But morality, if considered as an art, is that art which men have soonest and most constantly occasion to practise. Besides, we are so constituted by the wisdom of nature, that human actions, and the events which befal human beings, have more powerful influence than any other object to engage and fix our attention. Hence we are enabled to explain why morality, and these branches of literature more immediately connected with it, are almost always cultivated in preference to physical science. Though poetry, history, and morals, be pursued with no small eagerness and success in that period of society which we now consider, we need not therefore be greatly surprised that natural philosophy is neither very generally nor very successfully cultivated. Were we to consider each particular in that happy change which is now produced on the circumstances of mankind, we should be led into a too minute and perhaps unimportant detail. This is the period when human virtue and human abilities shine with most splendour. Rudeness, ferocity, and barbarism, are now banished. Luxury has made her appearance; but as yet she is the friend and the benefactress of society. Commerce has stimulated and rewarded industry, but has not yet contracted the heart and debased the character. Wealth is not yet become the sole object of pursuit. The charms of social intercourse are known and relished; but domestic duties are not yet deserted for public amusements. The female sex acquire new influence, and contribute much to refine and polish the manners of their lords. Religion now assumes a milder and more pleasing form; splendid rites, magnificent temples, pompous sacrifices, and gay festivals, give even superstition an influence favourable to the happiness of mankind. The gloomy notions and barbarous rites of former periods fall into disuse. The system of theology produced in former ages still remains: but only the mild and amiable qualities of the deities are celebrated; and none but the gay, humane, and laughing divinities, are worshipped. Philosophy also teaches men to discard such parts of their religion as are unfriendly to good morals, and have any tendency to call forth or cherish unsocial sentiments in the heart. War (for in this period of society enough of causes will arise to arm one nation against another)—war, however, no longer retains its former ferocity; nations no longer strive to extirpate one another: to procure redress for real or imaginary injuries; to humble, not to destroy, is now its object. Prisoners are no longer murdered in cold blood, subjected to horrid and excruciating tortures, or condemned to hopeless slavery. They are ransomed or exchanged; they return to their country, and again fight under its banners. In this period the arts of government are likewise better understood, and practised so as to contribute most to the interests of society. Whether monarchy, or democracy, or aristocracy, be the established form, the rights of individuals and of society are in general respected. The interests of society are so well understood, that the few, in order to preserve their influence over the many, find it necessary to act rather as the faithful servants than the imperious lords of the public. Though the liberties of a nation in this state be not accurately defined by law, nor their property guaranteed to them by any legal institutions, yet their governors dare not violate their liberties, nor deprive them wantonly of their properties. This is truly the golden age of society: every trace of barbarism is entirely effaced; and vicious luxury has not yet begun to sap the virtue and the happiness of the community. Men live not in listless indolence; but the industry in which they are engaged is not of such a nature as to overpower their strength or exhaust their spirits. The social affections have now the strongest influence on men's sentiments and conduct.

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Degeneracy and decline of society.

But human affairs are scarcely ever stationary. The circumstances of mankind are almost always changing, either growing better or worse. Their manners are ever in the same fluctuating state. They either advance towards perfection or degenerate. Scarcely have they attained that happy period in which we have just contemplated them, when they begin to decline till they perhaps fall back into a state nearly as low as that from which we suppose them to have emerged. Instances of this unhappy degeneracy occur more than once in the history of mankind; and we may finish this short sketch of the history of society by mentioning in what manner this degeneracy takes place. Perhaps, strictly speaking, every thing but the simple necessaries of life may be denominated luxury: For a long time, however, the welfare of society is best promoted, while its members aspire after something more than the mere necessaries of life. As long as these superfluities are to be obtained only by active and honest exertion; as long as they only engage the leisure hours, without becoming the chief objects of pursuit—the employment which they give to the faculties is favourable both to the virtue and the happiness of the human race.

The period arrives, however, when luxury is no longer serviceable to the interests of nations; when she is no longer a graceful, elegant, active form, but a languid, overgrown, and bloated carcase. It is the love of luxury, which contributed so much to the civilization of society, that now brings on its decline. Arts are cultivated and improved, and commerce extended, till enormous opulence be acquired: the effect of opulence is to awaken the fancy, to conceive ideas of new and capricious wants, and to inflame the breast with new desires. Here we have the origin of that selfishness which, operating in conjunction with caprice and the violence of unbridled

Society. unbridled paſſions, contributes ſo much to the corruption of virtuous manners. Selfiſhneſs, caprice, indolence, effeminacy, all join to looſen the bonds of ſociety, to bring on the degeneracy both of the uſeful and the fine arts, to baniſh at once the mild and the auſtere virtues, to deſtroy civil order and ſubordination, and to introduce in their room anarchy or deſpotiſm.

Scarcely could we have found an example of the beautiful form of ſociety which we laſt attempted to deſcribe. Never, at leaſt, has any nation continued long to enjoy ſuch happy circumſtances, or to diſplay ſo amiable and reſpectable a character. But when we ſpeak of the declining ſtate of ſociety, we have no difficulty in finding inſtances to which we may refer. Hiſtory tells of the Aſſyrians, the Egyptians, and the Perſians, all of them once flouriſhing nations, but brought low by luxury and an unhappy corruption of manners. The Greeks, the Romans, and the Aſſyrians, owed their fall to the ſame cauſes; and we know not if a ſimilar fate does not now threaten many of thoſe nations who have long made a diſtinguiſhed figure in the ſyſtem of Europe. The Portugueſe, the Venetians, and the Spaniards, have already fallen; and what is the preſent ſtate of our neighbours the French? They have long been a people deſtitute of religion, corrupted in morals, unſteady in conduct, and ſlaves to pleaſure and public amuſements. Among them luxury had arrived at its higheſt pitch; and the conſequence has been, that after capriciouſly ſhaking off the yoke of deſpotiſm, they have eſtabliſhed, or rather ſet up (for eſtabliſhed it cannot be), a motley kind of government, which, in the courſe of a few years, has exhibited ſcenes of tyranny and oppreſſion, to which we doubt if the annals of the world can furniſh any parallel. Yet this is the people whoſe manners the other nations of Europe were ambitious to imitate. May thoſe nations take warning in time, and avoid the rocks upon which they have ſplit.

15 Concluding remarks.

Thus have we viewed the ſeveral ſtages in which ſociety appears in its progreſs from rudeneſs to refinement and decay. The intelligent reader will perceive, that the various and anomalous phenomena which occur in the natural hiſtory of ſociety, cannot eaſily be ſolved; becauſe the neceſſary information cannot be obtained. Others have been well accounted for by the reſearches of curious philoſophical inquirers. Local circumſtances, the influence of climate, the intercourſe of nations in different ſtates of civilization, have been taken notice of, as cauſes ſerving to accelerate or retard the progreſs of arts and manners. But our proper buſineſs here was merely to mark the gradations between barbariſm and refinement: and as the painter who is to exhibit a ſeries of portraits repreſenting the human form in infancy, puerility, youth, and manhood, will not think of delineating all that variety of figures and faces which each of thoſe periods of life affords, and will find himſelf unable to repreſent in any ſingle figure all diverſities of form and features; ſo we have not once thought of deſcribing particularly under this article, all the various national characters reducible to any one of thoſe diviſions under which we have viewed the progreſs of ſociety, nor have found it poſſible to comprehend under one conſiſtent view, all the particulars which may be gathered from the remains of antiquity, from the relations of later travellers, and the general records of hiſtory concerning the progreſſive character of mankind in various regions, and under the influence of various accidents and circumſtances. This indeed would even have been improper, as all that information appears under other articles in this Work.

Societies. SOCIETIES, aſſociations voluntarily formed by a number of individuals for promoting knowledge, induſtry, or virtue. They may therefore be divided into three claſſes; ſocieties for promoting ſcience and literature, ſocieties for encouraging and promoting arts and manufactures, and ſocieties for diffuſing religion and morality and relieving diſtreſs. Societies belonging to the firſt claſs extend their attention to all the ſciences and literature in general, or devote it to one particular ſcience. The ſame obſervation may be applied to thoſe which are inſtituted for improving arts and manufactures. Thoſe of the third claſs are eſtabliſhed, either with a view to prevent crimes, as the Philanthropic Society; for the diffuſion of the Chriſtian religion among unenlightened nations, as the Society for the Propagation of the Goſpel in Foreign Parts; or for introducing arts and civilization, along with a knowledge of the Chriſtian religion, as the Sierra Leona company.

The honour of planning and inſtituting ſocieties for thoſe valuable purpoſes is due to modern times. A literary aſſociation is ſaid to have been formed in the reign of Charlemagne (ſee ACADEMY); but the plan ſeems to have been rude and defective. Several others were inſtituted in Italy in the 16th century; but from the accounts which we have ſeen of them, they ſeem to have been far inferior to thoſe which are moſt flouriſhing at preſent. The moſt enlarged idea of literary ſocieties ſeems to have originated with the great Lord Bacon, the father of modern philoſophy, who recommended to the reigning prince to inſtitute ſocieties of learned men, who ſhould give to the world from time to time a regular account of their reſearches and diſcoveries. It was the idea of this great philoſopher, that the learned world ſhould be united, as it were, into one immenſe republic; which, though conſiſting of many detached ſtates, ſhould hold a ſtrict union and preſerve a mutual intelligence with each other, in every thing that regards the common intereſt. The want of this union and intelligence he laments as one of the chief obſtacles to the advancement of ſcience; and, juſtly conſidering the inſtitution of public ſocieties, in the different countries of Europe, under the auſpices of the ſovereign, to be the beſt remedy for that defect, he has given, in his fanciful work, the New Atlantis, the delineation of a philoſophical ſociety on the moſt extended plan, for the improvement of all arts and ſciences; a work which, though written in the language, and tinctured with the colouring of romance, is full of the nobleſt philoſophic views. The plan of Lord Bacon, which met with little attention from the age in which he lived, was deſtined to produce its effect in a period not very diſtant. The ſcheme of a philoſophical college by Cowley is acknowledged to have had a powerful influence in procuring the eſtabliſhment of the Royal Society of London by charter from Charles II. §; and Cowley's plan is manifeſtly copied in almoſt all its parts from that in the New Atlantis. The inſtitution of the Royal Society of London was ſoon followed by the eſtabliſhment of the Royal Academy

§ *Sprat's Hiſtory of the Royal Society*, 2d edit. p. 39.

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demy of Sciences at Paris; and theſe two have ſerved as models to the philoſophical academies of higheſt reputation in the other kingdoms of Europe.

The experience of ages has ſhown, that improvements of a public nature are beſt carried on by ſocieties of liberal and ingenious men, uniting their labours without regard to nation, ſect, or party, in one grand purſuit alike intereſting to all, whereby mutual prejudices are worn off, and a humane philoſophical ſpirit is cheriſhed. Men united together, and frequently meeting for the purpoſe of advancing the ſciences, the arts, agriculture, manufactures, and commerce, may oftentimes ſuggeſt ſuch hints to one another as may be improved to important ends; and ſuch ſocieties, by being the repoſitories of the obſervations and diſcoveries of the learned and ingenious, may from time to time furniſh the world with uſeful publications which might otherwiſe be loſt: for men of ingenuity and modeſty may not chooſe to riſk their reputation, by ſending abroad unpatronized what a learned ſociety might judge richly worth the public eye; or perhaps their circumſtances being ſtraitened, they may not be able to defray the expence of publication. Societies inſtituted for promoting knowledge may alſo be of eminent ſervice, by exciting a ſpirit of emulation, and by enkindling thoſe ſparks of genius which otherwiſe might for ever have been concealed; and if, when poſſeſſed of funds ſufficient for the purpoſe, they reward the exertions of the induſtrious and enterpriſing with pecuniary premiums or honorary medals, many important experiments and uſeful diſcoveries will be made, from which the public may reap the higheſt advantages.

Eminent inſtances of the beneficial effects of ſuch inſtitutions we have in the Royal Academy of Sciences at Paris, the Royal Society, and the Society inſtituted for the Encouragement of Arts, Manufactures, and Commerce, in London, and many others of a ſimilar kind. Hereby a ſpirit of diſcovery and improvement has been excited among the ingenious in almoſt every nation; knowledge of various kinds, and greatly uſeful to mankind, has taken place of the dry and unintereſting ſpeculations of ſchoolmen; and bold and erroneous hypotheſis has been obliged to give way to demonſtrative experiment. In ſhort, ſince the eſtabliſhment of theſe ſocieties, ſolid learning and philoſophy have more increaſed than they had done for many centuries before.

As to thoſe ſocieties eſtabliſhed for promoting induſtry, religion and morality, and relieving diſtreſs, the deſign is laudable and excellent, and preſents a beautiful picture of the philanthropy of modern times. We are happy to find, from the minutes of ſome of theſe ſocieties, that their beneficial effects are already conſpicuous.

We will now give ſome account of the moſt eminent ſocieties; arranging them under the three claſſes into which we have divided them: I. *Religious and Humane Societies.* II. *Societies for Promoting Science and Literature.* III. *Societies for Encouraging Arts, Manufactures*, &c.

I. Religious and Humane Societies.

1. *Society for the Propagation of the Goſpel in Foreign Parts*, was inſtituted by King William III. in 1701, in order to ſecure a maintenance for an orthodox clergy, and to make other proviſions for propagating the goſpel in the plantations, colonies, and factories beyond the ſeas. To that end he incorporated the archbiſhops, ſeveral of the biſhops, and others of the nobility, gentry, and clergy, to the number of 90, into one body, which, by the name of *The Society for the Propagation of the Goſpel in Foreign Parts*, was to plead and be impleaded; to have perpetual ſucceſſion, with privilege to purchaſe 2000l. a-year inheritance, and eſtates for lives or years, with other goods and chattels to any value. By its charter the ſociety is authoriſed to uſe a common ſeal, and to meet annually on the third Friday in February for the purpoſe of chooſing a preſident, vice-preſident, and officers for the year enſuing; and on the third Friday in every month, or oftener if there ſhould be occaſion, to tranſact buſineſs, and to depute perſons to take ſubſcriptions, and collect money contributed for the purpoſes aforeſaid; and of all moneys received and laid out, it is obliged to give account yearly to the lord-chancellor or keeper, the lord-chief-juſtice of the King's-bench, the lord-chief-juſtice of the Common-pleas, or to any two of theſe magiſtrates. Of this ſociety there is a ſtanding committee at St Paul's chapter-houſe, to prepare matters for the monthly meeting, which is held at St Martin's library.

Before the incorporation of the ſociety for the propagation of the goſpel in foreign parts, there had been formed, for the promoting of Chriſtian knowledge both at home and in the colonies, a voluntary aſſociation of perſons of rank and reſpectability, who in March 1699 began to hold ſtated meetings in London for that purpoſe, regulating themſelves by the laws of the land and the canons of the church; and when the new ſociety was formed, they had already tranſmitted to America and the Weſt Indies 800l. worth of Bibles, Books of Common Prayer, and treatiſes of practical religion, beſides ſecuring a tolerable maintenance to ſeveral clergymen on that continent. This aſſociation ſtill ſubſiſts under the denomination of *The Society for Promoting Chriſtian Knowledge*, and has been productive of much good in the cities of London and Weſtminſter; but upon the formation of the new ſociety, into which all its original members were incorporated by name, the care which the voluntary aſſociation had taken of the colonies devolved of courſe upon the incorporated ſociety; of which incorporation we believe the object has been ſometimes miſtaken, and the labours of its miſſionaries groſsly miſrepreſented. It has by many been ſuppoſed that the ſociety was incorporated for the *ſole* purpoſe of converting the ſavage Americans; and it has been much blamed for ſending miſſionaries into provinces where, in the common language of the complainers, a *goſpel-miniſtry* was already eſtabliſhed. But an impartial view of the riſe and progreſs of the American provinces, now become independent ſtates, will ſhow the folly and injuſtice of thoſe complaints.

The Engliſh colonies in North America were in the laſt century formed and firſt peopled by religious men; who made uneaſy at home by their intolerant brethren, left the *old world* to enjoy in peace that firſt and chief prerogative of man, *the free worſhip of God according to his own conſcience*. At one time Puritans were driven acroſs the Atlantic by the epiſcopal church; at another, Churchmen were forced away by the preſbyterians, juſt as the revolutions of ſtate threw the civil power into the hands of the one or the other party; and not a few

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members of the CHURCH OF ROME were chafed to the wilds of America by the united exertions of both. It has been often obferved, that people perfecuted for their religion become for the moft part enthufiaftically attached to it; and the conduct of thofe colonifts was in perfect harmony with this obfervation. Their zeal, inflamed by their violent removal to the other hemifphere, kept religion alive and active among themfelves; but their poverty difabled them from fupplying fuel to the flame, by making provifion for a miniftry to inftruct their offspring. The confequence was, that the new Chriftian commonwealth, without the kindly affiftance of its mother-country, would have been, in the words of the Roman hiftorian, *Res unius ætatis*. Againft this danger a timely aid was to be provided by the fociety; which, as it confifted not of fanatical members, would not intruft the important bufinefs of the miffion to fanatical preachers, who, though always ready for fuch fpiritual enterprifes, are never qualified to carry them on with fuccefs.

It was therefore thought fit to affign a decent maintenance for clergymen of the church of England, who might preach the gofpel to their brethren in America: and though thofe miffionaries in general carefully avoided the conduct of thofe of Rome, whofe principal aim is to reduce all churches under fubmiffion to the papal tyranny; yet fo lately as 1765, did fome of the colonies, in which the puritanic fpirit of the laft century characterifed the church eftablifhed by law, raife a hideous outcry againft the fociety for fending a miffion into their quarters, though only for the fervice of the difperfed members of the Epifcopal church refiding among them, and for the converfion of thofe men whom their rigid fanaticifm had prejudiced againft Chriftianity itfelf.

Indeed the commodity called FREETHINKING, as Bifhop Warburton expreffes it, was at an early period imported by the opulent and fafhionable colonifts. The celebrated Berkeley, who had refided fome years in Rhode Ifland, and at his return was called upon to preach the anniverfary fermon before the fociety, informs us, that the ifland where he lived was inhabited by an Englifh colony, confifting chiefly of fectaries of many different denominations; that feveral of the better fort of the inhabitants of towns were accuftomed to affemble themfelves regularly on the Lord's day for the performance of divine worfhip; but that moft of thofe who were difperfed through the colony rivalled fome well-bred people of other countries, in a thorough indifference for all that is facred, being equally carelefs of outward worfhip and of inward principles. He adds, that the miffionaries had done, and were continuing to do, good fervice in bringing thofe planters to a ferious fenfe of religion. "I fpeak it knowingly (fays he), that the minifters of the gofpel, in thofe provinces which go by the name of New England, fent and fupported at the expence of the fociety, have, by their fobriety of manners, difcreet behaviour, and a competent degree of ufeful knowledge, fhown themfelves worthy of the choice of thofe who fent them." We have the honour to be acquainted with fome of the miffionaries fent at a later period, and have reafon to believe that, down to the era of the American revolution, they had the fame virtues, and were doing the fame good fervices, which procured to their predeceffors this honourable teftimony from one of the greateft and the beft of men. Surely fuch a miffion deferved not to be evil fpoken of by fectarifts of any denomination who believe in Chrift; efpecially as the very charter of incorporation affigns as a reafon for miffionaries being fent to the colonies, "that by reafon of their poverty thofe colonies were deftitute and unprovided of a MAINTENANCE for minifters and the public worfhip of God."

* See his *Sermon*, vol. ii. of his *Works*, 4to.

The fociety, however, was incorporated for other purpofes than this. It was obliged by its charter to attempt the converfion of the native Americans and the negro flaves; and we have reafon to believe, that, as foon as the fpiritual wants of the colonifts were decently fupplied, it was not inattentive to thefe glorious objects. Its fuccefs indeed in either purfuit has not been fo great as could be wifhed; but it would be rafh and unfair to attribute this failure to the prefident, vice-prefident, or other officers of the corporation at home. An erroneous notion, that the being baptized is inconfiftent with a ftate of flavery, rendered the felfifh colonifts for a long time averfe from the converfion of their negroes, and made them throw every obftacle in the way of all who made the attempt; while the difficulties of the Indian miffion are fuch as hardly any clergyman educated in a Proteftant country can be fuppofed able to furmount.

He who hopes fuccefsfully to preach the gofpel among a tribe of favage wanderers, muft have an ardent zeal and unwearied diligence; appetites fubdued to all the diftreffes of want; and a mind fuperior to all the terrors of mortality. Thefe qualities and habits may be acquired in the church of Rome by him who from infancy has been trained up in the feverities of fome of the monaftic orders, and afterwards fent to the college *de propaganda fide* to be inftructed in the languages, and inured to the manners and cuftoms, of the barbarous nations whofe converfion he is deftined to attempt. But in the reformed churches of Britain there are no monaftic orders, nor any college *de propaganda fide;* and yet without the regular preparation, which is to be looked for in fuch inftitutions alone, it is not in nature, whatever grace may effect, for any man cheerfully, and at the fame time foberly, to undergo all the accumulated diftreffes ever ready to overtake a faithful miffionary among favage idolaters. A fanatic zealot will indeed undertake it, though he is totally unqualified for every fober and important work; and a man of ruined fortunes may be preffed into the fervice, though the impotency of his mind has fhown him unable to bear either poverty or riches. The failure of the fociety therefore in its attempts to convert the American Indians may be attributed, we think, in the firft inftance, to the want of a college *de propaganda* for training up young men for the American miffion.

Perhaps another caufe of this failure may be found in the conduct of the miffionaries, who, it is to be prefumed, have not always employed in a proper manner even the fcanty qualifications which they actually poffeffed. The gofpel, plain and fimple as it is, and fitted in its nature for what it was ordained to effect, cannot be apprehended but by an intellect fomewhat raifed above that of a favage. Such of the miffionaries therefore as began their work with *preaching to favage and brutal men*, certainly fet out at the wrong end; for to make the gofpel underftood, and much more to propagate

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gate and eſtabliſh it, thoſe ſavages ſhould have been firſt taught the neceſſary arts of civil life, which, while they improve every bodily accommodation, tend at the ſame time to enlarge and enlighten the underſtanding. For want of this previous culture, we doubt not, it hath happened that ſuch of the ſavages as have been baptized into the faith have ſo ſeldom perſevered themſelves, or been able in any degree to propagate among their tribes the Chriſtianity which they had been taught, and that ſucceſſive miſſions have always found it neceſſary to begin anew the work of converſion.

To one or other of theſe cauſes, or to both, may juſtly be attributed the little progreſs which reformed Chriſtianity has made among the Indians of North America; and not to any want of zeal, attention, or liberality, in the directors of the ſociety at home. During the dependence of the United States on the mother-country, great part of the ſociety's funds was properly expended in keeping alive a juſt ſenſe of religion among the Chriſtian coloniſts from Europe, who had ſurely the firſt claims upon this beſt of charities; but now that America has ſeparated herſelf from Great Britain, and ſhown that ſhe is able to maintain her independence, and to make ample proviſion for a regular clergy of her own, the members of the corporation muſt feel themſelves at liberty to beſtow greater attention, and to expend more money than they could formerly do, on the converſion of ſuch Indians as have any intercourſe with the ſettlements which we ſtill poſſeſs. To a body ſo reſpectable, we preſume not to offer advice; but we cannot help thinking, with Biſhop Berkeley, that the moſt ſucceſsful miſſionaries would be children of Indians, educated in a conſiderable number together from the age of ten or twelve in a college *de propaganda fide*, where they ſhould be in no danger of loſing their mother-tongue while they were acquiring a competent knowledge of religion, morality, hiſtory, practical mathematics, and agriculture. "If there were a yearly ſupply (ſays he) of a dozen ſuch miſſionaries ſent abroad into their reſpective countries, after they had received the degree of maſter of arts, and been admitted into holy orders, it is hardly to be doubted but that in a little time the world would ſee good and great effects of their miſſion."

Propoſal for the better ſupplying of Churches in our Foreign Plantations, &c.

2. *Society in Scotland for Propagating Chriſtian Knowledge*, was inſtituted in the beginning of the eighteenth century. At that period the condition of the Scotch Highlanders was truly deplorable. Shut up in deſolate iſlands by tempeſtuous ſeas, or diſperſed over a wide extent of country, interſected by high mountains, rapid rivers, and arms of the ſea, without bridges or highways, by which any communication could be kept open either with remote or neighbouring diſtricts, they lived in ſmall detached companies in hamlets or ſolitary huts. Being thus ſecluded from intercourſe with the more civilized part of the iſland, they could not enjoy the advantages of trade and manufactures. As their ſoil was barren and their climate ſevere, in agriculture no progreſs was to be expected: and as they were acquainted with no language but Gaelic, in which no books were then written, to poſſeſs knowledge was impoſſible. Their pariſhes being of great extent, often 30 or 40 miles long and of a proportionable breadth, and ſometimes conſiſting of ſeveral iſlands ſeparated by ſeas, which are often impaſſable, a conſiderable number of the inhabitants was entirely deprived of religious inſtruction or fell a prey to Popiſh emiſſaries. A ſingle ſchool in ſuch extenſive pariſhes could be of little benefit; yet many pariſhes were entirely deſtitute even of this reſource; and where ſchools were eſtabliſhed, the want of books prevented them from producing the uſeful effects otherwiſe to have been expected from them (A). To all this we muſt add, that they lived in a ſtate of the greateſt oppreſſion: For though the Highlands formed a part of the Britiſh empire, the bleſſings of the Britiſh conſtitution had not reached them. The feudal ſyſtem reigned in its utmoſt rigour; the chieftains exerciſing the moſt deſpotic ſway over the inferior Highlanders, whom at their pleaſure they deprived of their lives or property (B).

Thus the Highlanders were ignorant, oppreſſed, and uncivilized; ſlaves rather than ſubjects; and either entirely deſtitute of the advantages of the Chriſtian religion, or unqualified to improve them. Hitherto they had been unhappy and uſeleſs to themſelves and dangerous to the ſtate; for they were ready at the call of their chieftains to iſſue from their mountains, and to turn their arms againſt their lawful king and his loyal ſubjects. This character, however, aroſe from their ſituation. It was therefore impoſſible for benevolent minds to contemplate this unhappy ſituation of their countrymen without feeling a deſire to raiſe them to the dignity of rational beings, and to render them uſeful as citizens.

Accordingly, in the year 1701, ſome private gentlemen of the city of Edinburgh, who had formed themſelves into a ſociety for the reformation of manners, directed their attention to the Highlands of Scotland, and endeavoured to deviſe ſome plan for alleviating the diſtreſſes of the inhabitants. The remedy which promiſed to be moſt efficacious was, to eſtabliſh charity ſchools in different places, But as the exigency was great, it was no eaſy matter to raiſe a ſufficient fund for this purpoſe. They began therefore with what voluntary ſubſcriptions they could procure, hoping afterwards to increaſe their capital by vacant ſtipends and public contributions. A memorial with this view was preſented to the General Aſſembly in 1704, which received their approbation; and they accordingly paſſed an act, recommending a general contribution. In 1706 the General Aſſembly appointed ſome of their number to inquire more carefully into the ſtate of the Highlands, and the year following appointed a ſelect committee to confer with the gentlemen who had ſuggeſted the plan. The reſult of theſe conferences was the publication of propoſals "for propagating Chriſtian knowledge

(A) Even ſo late as the year 1758, not fewer than 175 pariſhes, within the bounds of 39 preſbyteries, had no parochial ſchool. We are ſorry to add, that even in the preſent enlightened and benevolent age the complaint is not entirely removed.

(B) The feudal ſyſtem was at length aboliſhed in the year 1748 by the juriſdiction act.

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ledge in the Highlands and Iſlands of Scotland, and in foreign parts of the world." Copies of theſe propoſals, with ſubſcription papers, were diſtributed through the kingdom; and the contributions having ſoon amounted to 1000l. her majeſty Queen Anne encouraged this infant ſociety by her royal proclamation, and at the ſame time iſſued letters patent under the great ſeal of Scotland for erecting certain of the ſubſcribers in to a corporation; the firſt nomination of whom was lodged with the lords of council and ſeſſion.

This corporation held its firſt meeting on Thurſday 3d November 1709. It was attended by ſeveral of the nobility, fourteen of the lords of ſeſſion, many gentlemen of rank, together with moſt of the miniſters of the city of Edinburgh and neighbourhood. A preſident, ſecretary, and treaſurer, with a committee of fifteen directors, were appointed for the diſpatch of buſineſs. At their ſecond meeting in January 1710, a ſcheme of management was formed and approved; in which it was propoſed, 1. To erect and maintain ſchools in ſuch places of Scotland, particularly in the Highlands and Iſlands, as ſhould be found to need them moſt; in which ſchools all perſons whatſoever ſhould be taught by fit and well qualified ſchoolmaſters, appointed by the ſociety, to read the Holy Scriptures and other pious books; as alſo to write, and to underſtand the common rules of arithmetic, with ſuch other things as ſhould be thought ſuitable to their circumſtances. 2. That the ſchoolmaſters ſhould be particularly careful to inſtruct their ſcholars in the principles of the Chriſtian reformed religion; and for that end ſhould be obliged to catechiſe them at leaſt twice a week, and to pray publicly with them twice a-day. 3. That not only ſuch as were unable to pay ſhould be taught gratis, but that thoſe whoſe circumſtances required it, ſhould have ſuch farther encouragement as the ſociety ſhould think fit in a conſiſtency with their patent. 4. To name ſome prudent perſons, miniſters and others, to be overſeers of thoſe ſchools, who ſhould take care that the ſchoolmaſters do their duty, and that the inſtructions to be given from time to time by the ſociety or their committee be punctually obſerved; which overſeers ſhould make their report to the ſociety quarterly or half-yearly at fartheſt. 5. To give ſuitable encouragement to ſuch miniſters or catechiſts as ſhould be willing to contribute their aſſiſtance towards the farther inſtruction of the ſcholars remote from church, by not only catechiſing, but preaching to them; which miniſters or catechiſts ſhould take the ſame care of the other inhabitants as of the ſcholars. 6. To extend their endeavours for the advancement of the Chriſtian religion to heathen nations; and for that end to give encouragement to miniſters to preach the goſpel among them.

Having thus formed a plan, they immediately proceeded to eſtabliſh ſchools in the moſt uſeful and economical manner; and as the capital continued to accumulate, the intereſt was faithfully applied, and the utility of the inſtitution was more extenſively diffuſed.

Until the year 1738 the attention of the ſociety had been wholly directed to the eſtabliſhment of ſchools; but their capital being then conſiderably augmented, they began to extend their views of utility much farther. The grand object of all public aſſociations ought certainly to be the promoting of religion and morality. It muſt, however, be evident to every man of reflection, that theſe can neither be propagated nor preſerved among a people without agriculture, unaccuſtomed to commerce and manufactures, and conſequently without labour or exertion. Languor and debility of mind muſt always be the companions of idleneſs. While the Highlanders roved about with arms in their hands, the latent vigour of their minds muſt often have been called forth into action; but when their arms were taken away, and themſelves confined to a domeſtic life, where there was nothing to rouſe their minds, they muſt have ſunk into indolence and inactivity. All attempts therefore to inſtruct them in religion and morality, without introducing among them ſome of the neceſſary arts of life, would probably have been unavailing. The ſociety accordingly reſolved to adopt what appeared to them the moſt effectual methods of introducing induſtry among the Highlanders. But as their patent did not extend far enough, they applied to his majeſty George II. for an enlargement of their powers; and accordingly obtained a ſecond patent, by which they are empowered, "beſides fulfilling the purpoſes of their original patent, to cauſe ſuch of the children as they ſhall think fit to be bred to huſbandry and houſewifery, to trades and manufactures, or in ſuch manual occupations as the ſociety ſhall think proper."

The objects of this ſecond patent the ſociety have not failed to purſue; and though many obſtacles and diſcouragements to their efforts occurred among a rude and barbarous people, yet their perſeverance, and the obvious utility of their plans, at length ſo far overcame the reluctance of the inhabitants, that not fewer than 94 ſchools of induſtry in various parts of the Highlands and Iſlands are now upon their eſtabliſhment, at which are educated 2360 ſcholars.

The ſociety, while anxiouſly endeavouring to diffuſe a ſpirit of induſtry through the Highlands, were ſtill equally ſolicitous to promote the knowledge of the Chriſtian religion. As the Engliſh language had been the only channel by which knowledge was conveyed to them (a language which, being not uſed in converſation, was in all reſpects foreign to them), it was judged requiſite that they ſhould have the Scriptures in their vernacular tongue. The ſociety therefore firſt appointed a tranſlation of the New Teſtament to be made into Gaelic: A tranſlation was accordingly undertaken by the Rev. Mr Stewart miniſter of Killin in Perthſhire, and printed in 1767, which is ſaid to be executed with much fidelity. Of this work many thouſand copies have been diſtributed in the Highlands. The greater part of the Old Teſtament has alſo been tranſlated by the Rev. Dr Smith of Campbelton and others, but chiefly by the Rev. Dr Stewart of Luſs, by the appointment and at the expence of the ſociety: and as ſoon as the remaining part can be got ready, the whole will be ſold at ſo low a price as the poor may without difficulty afford. This plan the ſociety have judiciouſly choſen, in order to prevent diſcontent and murmuring; effects which the diffuſion of the Scriptures ought never to produce; but which could not poſſibly have been prevented, had the diſtribution been gratuitous, and of courſe partial.

For ſome years paſt the funds of the ſociety have ra-

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pidly accumulated, from the very liberal donations of several individuals.

Lady Glenorchy -	L. 5,000
By a person unknown -	10,000
Lord Van Vryhouven of Holland	20,000
Miss Gray of Teasses -	3,500

In consequence of these great additions to their stock, insinuations have been thrown out that the society have become so wealthy as to be at a loss for proper objects on which to bestow their increased revenue. If such an opinion be *seriously* entertained by any one, we must beg him to remember, that the society have erected and endowed not fewer than 323 schools for religion, the first principles of literature and industry, at the annual expence of 3214l. 10s. sterling; and that at these seminaries are educated from 14,000 to 15,000 children; who, but for the means of instruction thus obtained, would in all probability be bred up in ignorance and idleness: That they employ 12 missionary ministers and catechists in remote parts of the Highlands and islands, or among the ignorant Highlanders settled in the great towns of Scotland, at the annual expence of 296l.: That they bestow a bursary or pension of 15l. per annum on each of six students of divinity having the Gaelic language: That they employ two missionary ministers and one schoolmaster among the Oneida and Stockbridge Indians of North America (being the destination of certain legacies bequeathed to them for that purpose), at the annual expence of 140l. Such is their fixed scheme of annual expenditure, amounting in all to 3740l., 10s. sterling—a sum it will be acknowledged of very considerable magnitude. The whole of their incidental expences arising from the Gaelic translation of the Scriptures of the Old Testament; from annuities which they have to pay, in consequence of sums left them as residuary legatees; from land and house taxes; from enabling candidates for the office of schoolmaster to come to Edinburgh for examination; from furnishing books to poor scholars in their various schools; and from removing schoolmasters from one station to another, is generally about 875l., which added to the former sum makes the whole annual expence amount to 4615l. 10s.

If it be inquired at what expence, in the *management* of it, this extensive and complicated charity is annually conducted, we are authorised to say, that the treasurer, bookholder, and clerk, are allowed each 25l. per annum, the same salaries which were annexed to these offices from the commencement of the society. The beadle or officer is allowed 12l. per annum. No salary whatever is enjoyed by any of the other officers of the society. The secretary, comptroller, accountant, and librarian, although subjected, some of them especially, to no small expence of time and labour, have no pecuniary recompense or emolument. Theirs are labours of love, for which they seek and expect no other reward than the consciousness of endeavouring to promote the best interests of mankind. The whole amount of the expence of managing the business of the society, including the above salaries, and coals, candle, stationary ware, postages, and other incidents, exceeds not at an average 115l. per annum. From this statement it appears, that hitherto at least the directors have been at no loss for important objects within the proper sphere of their institution on which to bestow their increased funds. They have, it is true, the disposal of very considerable sums for promoting the objects of the institution; but they are so far from accumulating wealth, that every year their expenditure, notwithstanding the late increase of their capital, exceeds rather than falls short of their income. They have depended upon a kind Providence and a generous public to refund these anticipations of their revenue, and hitherto they have never been disappointed.

Thus has the Society for Propagating Christian Knowledge proceeded for almost a century. It was founded by the pious exertions of a few private individuals, whose names are unknown to the world; and its funds, by faithful and judicious management, as well as by generous contributions, have now become of such magnitude, as to excite the hope that they will be productive of the most valuable effects. The benefits arising from public societies, it is well known, depend entirely upon the management of their directors. If so, the advantages which have accrued from this society intitle it to the praise and gratitude of the nation. While eager to increase the number of schools, the society have not been inattentive to their prosperity. In the year 1771 Mr Lewis Drummond, a gentleman in whom they placed great confidence, was commissioned by them to visit their schools, and to make an exact report of their state and circumstances. Again, in the year 1790, a commission was granted to the Rev. Dr Kemp, one of the ministers of Edinburgh and secretary to the society, to visit all the schools on their establishment. This laborious and gratuitous task he accomplished in the course of four summers with much ability and care, and highly to the satisfaction of the society. At his return he communicated a variety of important information respecting the state of the Highlands and Islands, and the means necessary for their improvement in religion, literature, and industry; an abstract of which was published by the society in appendixes to the anniversary sermons preached before them in the years 1789, 90, 91, and 92 (c)

The following table will exhibit at a glance the funds, establishment, and expenditure, of the society, from a few years after its commencement to the present time. Where

(c) It is well known, that the number of Roman Catholics in the Highlands is considerable; but it must give much pleasure to the Protestant reader to be informed, that the ancient malignant spirit of Popery has in that district given place to mildness and liberality. This is chiefly owing to the gentleman who superintends the priests in that quarter, whose mind is enlightened by science and learning. So far from being hostile to the views of the society, he recommended to his clergy to promote them. They accordingly received the secretary with much politeness; exhorted the people to send their children to the Protestant schools to be instructed in literature, to be taught to read the Scriptures in their own language, and to be made acquainted with those great principles of religion in which all Christians are agreed. What a blessed reformation!

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Where the number of fcholars is not mentioned, the defect may be fupplied by taking an average from thofe years where a computation has been made. Where the capital is not mentioned, it may eafily be made out by confidering the falaries as the intereft.

A. D.	Capital.	Schools.	Scholars.
1713		12	
1715	L. 6,177	25	
1719	8,168	48	
1727	9,131	78	2757
1732	13,318	109	
1742	19,287	128	
1753	24,328	152	
1758	28,413	176	6409
1781	34,000	180	7000
	Salaries		
1793	3,080	307	12,913
1794	3,214	323	14,370

Hitherto we have taken no notice of the correfponding board which was eftablifhed at London fo early as the year 1729, to receive fubfcriptions and lay out fums. That board indeed remained long inactive; but in 1773 its members began to co-operate more cordially with their brethren in Scotland. Since that period an annual fermon has been preached in recommendation of the charity; and the preacher is now felected without any regard to the religious denomination to which he belongs; fometimes from the church of England, fometimes from the church of Scotland, and fometimes from fectaries of different perfuafions. The meetings of the correfpondent board have been attended by many of the nobility and gentry, who have made great exertions to promote the views of the fociety. From its prefent flourifhing ftate therefore, from the indefatigable exertion and laudable zeal of the managers, and from the countenance and fupport which they have received from perfons of the firft rank and refpectability in the nation, the benevolent mind may look forward with much confidence and fatisfaction to a period not very diftant, when its beneficial effects fhall be felt not only in the Highlands, but fhall be communicated to the reft of the nation. We have been thus particular in our account of the Society for Propagating Chriftian Knowledge, becaufe we have had accefs to the moft authentic fources of information, and becaufe we know it to be an inftitution calculated to enlighten and improve a confiderable part of the Britifh nation.

3. *Society of the Sons of the Clergy*, was incorporated by King Charles II. in 1678, by the name of *The Governors of the Charity for Relief of the Poor Widows and Children of Clergymen.* This fociety is under the direction and management of a prefident and vice prefident, three treafurers, and a court of affiftants compofed of forty members. Several hundreds of widows and children of the clergy have annually received confiderable relief from this ufeful charity.

4. *Society for the Sons of the Clergy of the Eftablifhed Church of Scotland*, was inftituted at Edinburgh in February 1790, and was conftituted a body corporate by his majefty's royal charter in 1792. The fociety, after feveral meetings, are of opinion, that the period in which the families of clergymen feel moft urgently the need both of friends and of pecuniary aid, is that which commences with the introduction of the fons either to an univerfity or to bufinefs, and terminates with their eftablifhment in their refpective profeffions; that many of the minifters of this church, living at great diftances from the feats either of univerfities or of bufinefs, poffefs incomes which, in the prefent ftate of the country, are inadequate to the purpofes of procuring for their fons either the literary or profeffional education which might enable them to come forward with credit and fuccefs in the world; that the fons of clergymen, from domeftic tuition and example, have in general very advantageous means of receiving in their early years the impreffions of virtue and honour, together with the rudiments of liberal knowledge; and that of courfe the public intereft may be promoted, by enabling this clafs of young men to obtain their fhare in the refpectable fituations of life. The views of the fociety have been limited to the fons only of clergymen; as they are of opinion, that within the limits which they have fixed, the field of beneficence will be ftill very extenfive, and the claims for aid as many and as great as their funds can be fuppofed able to anfwer, at leaft for many years to come. If the fociety fhall ever be in a fituation to undertake more than the aids which will be neceffary in bringing forward the fons of the clergy, it may then be confidered in what manner the daughters alfo may become fharers in its bounty.

A fociety of the fame nature, and having the fame objects in view, was inftituted at Glafgow we think the year before; and both focieties, we know, have in many cafes proved highly beneficial in promoting the views for which they were inftituted.

5. *Royal Humane Society*, was inftituted in London in 1774, for the recovery of perfons drowned or otherwife fuffocated. We have already given fome account of focieties inftituted in other countries with the fame views, and have alfo copied the directions of this fociety for the recovery of life, for which fee the article DROWNING. We have therefore only to ftate, that the plan of this fociety is fo averfe to any private interefted views, that it acquits its founders of all fordid motives. For the medical practitioners accept no pecuniary recompenfe for the time which they devote to a difficult and tedious procefs; for the anxiety which they feel while the event is doubtful: for the mortification which they too often undergo, when death, in fpite of all their efforts, at laft carries off his prey; nor for the infults to which they willingly expofe themfelves from vulgar incredulity. Their fole reward is in the holy joy of doing good. Of an inftitution thus free in its origin from the fufpicion of ambitious views, and in its plan renouncing felf-intereft in every fhape, philanthropy muft be the only bafis. The good intention therefore of the fociety is proved by its conftitution; the wifdom and utility of the undertaking are proved by its fuccefs: not fewer than 3000 fellow-creatures having fince its commencement been (1794) reftored to the community by its timely and indefatigable exertions. For it is to be obferved, that the benefit of this fociety is by no means confined to the two cafes of drowning and fufpenfion. Its timely fuccours have roufed the lethargy of opium taken in immoderate and repeated dofes; they have refcued the wretched victims of intoxication; rekindled the life extinguifhed by the fudden ftroke of lightning; recovered the apoplectic; reftored life to the infant that had loft it in the birth; they have proved efficacious

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efficacious in cases of accidental smothering and of suffocation by noxious damps; in instances in which the tenderness of the infant body or the debility of old age greatly lessened the previous probability of success: insomuch that no species of death seems to be placed beyond the reach of this society's assistance, where the mischief had gone no farther than an obstruction of the movements of the animal machine without any damage of the organs themselves. In consequence of every necessary assistance afforded by this society, similar institutions have been established at Algiers, Lisbon, Philadelphia, Boston, Jamaica, Dublin, Leith, Glasgow, Paisley, Aberdeen, Birmingham, Gloucester, Shropshire, Northamptonshire, Lancaster, Bristol, Whitehaven, Norwich, Exeter, Kent, and Newcastle. The society has published an 8vo volume with plates, consisting of cases, correspondence, and a variety of interesting matter relating to the object of this benevolent institution.

6. *The Philanthropic Society*, was instituted in September 1788. It aims at the prevention of crimes, by removing out of the way of evil counsel, and evil company, those children who are, in the present state of things, destined to ruin. It proposes to educate and instruct in some useful trade or occupation the children of convicts or other infant poor who are engaged in vagrant or criminal courses; thus to break the chain of those pernicious confederacies, deprive the wicked of successors, the gaols of inhabitants, justice of its victims, and by all these means add citizens to society. This institution is not only calculated to decrease vice and infamy, but to increase useful industry; so that those children who would otherwise succeed to their parents hereditary crimes, and become the next race of beggars and thieves, will now be taught to supply by honest means their own wants and the wants of others.

To carry into effect these desirable purposes, it is the first business of the society to select from prisons, and from the haunts of vice, profligacy, and beggary, such objects as appear most likely to become obnoxious to the laws, or prejudicial to the community; and, in the execution of this duty, the assistance of the magistrates, the clergy, and all who are interested in the promotion of good morals and good government, is most earnestly requested. For the employment of the children, several houses are supported, at Cambridge Heath, near Hackney, in each of which a master-workman is placed for the purpose of teaching the children some useful trade. The trades already established are those of a printer, carpenter, shoemaker, and taylor. The girls are at present educated as menial servants.

In the year 1791 not fewer than 70 children were under the protection of this society, among whom were many who have been guilty of various felonies, burglaries, and other crimes. Yet, singular as it may appear, in less than two years those very children became no less remarkable for industry, activity, decency, and obedience, than they formerly were for the contrary vices. Such are the grounds on which the Philanthropic Society now claims the attention and solicits the patronage of the public. If we regard humanity and religion, this institution opens an asylum to the most forlorn and abject of the human race; it befriends the most friendless; it saves from the certain and fatal consequences of infamy and vicious courses orphans and deserted children. If we regard national prosperity and the public welfare, it is calculated to increase industry; and it directs that industry into the most useful and necessary channels. If we regard self-interest, its immediate object is to protect our persons from assault and murder, our property from depredation, and our peaceful habitations from the desperate fury of midnight incendiaries.

One guinea per annum constitutes a member of the society; and 10l. at one payment a member for life. A life-subscription, or an annual payment of at least two guineas, is a necessary qualification for being elected into the committee.

II. Societies for Promoting Science and Literature.

1. *The Royal Society of London* is an academy or body of persons of eminent learning, instituted by Charles II. for the promoting of natural knowledge. The origin of this society is traced by Dr Sprat, its earliest historian, no farther back than to "some space after the end of the civil wars" in the 17th century. The scene of the first meetings of the learned men who laid the foundation of it, is by him fixed in the university of Oxford at the lodgings of Dr Wilkins warden of Wadham college. But Dr Birch, on the authority of Dr Wallis, one of its earliest and most considerable members, assigns it an earlier origin. According to him, certain worthy persons, residing in London about the year 1645, being "inquisitive into natural and the new and experimental philosophy, agreed to meet weekly on a certain day, to discourse upon such subjects, and were known by the title of *The Invisible* or *Philosophical College*." In the years 1648 and 1649, the company who formed these meetings was divided, part retiring to Oxford and part remaining in London; but they continued the same pursuits as when united, corresponding with each other, and giving a mutual account of their respective discoveries. About the year 1659 the greater part of the Oxford society returned to London, and again uniting with their fellow-labourers, met once, if not twice, a-week at Gresham college, during term time, till they were scattered by the public distractions of that year, and the place of their meeting made a quarter for soldiers. On the restoration 1660 their meetings were revived, and attended by a greater concourse of men eminent for their rank and learning. They were at last taken notice of by the king, who having himself a considerable taste for physical science, was pleased to grant them an ample charter, dated the 15th of July 1662, and afterwards a second dated 15th April 1763, by which they were erected into a corporation, consisting of a president, council, and fellows, for promoting natural knowledge; and to give their investigations, against which strange prejudices were entertained, every possible support, he sometimes honoured their meetings with his presence.

Their manner of electing fellows is by balloting. Their council are in number 21, including the president, vice-president, treasurer, and two secretaries; 11 of which are continued for the next year, and 10 more added to them; all chosen on St Andrew's day. Each member at his admission subscribes an engagement that he will endeavour to promote the good of the society, from which he may be freed at any time, by signifying to the president that he desires to withdraw. The charges have been different at different times, and were at were at first irregularly paid: but they are now five guineas paid to the treasurer at admission, and 13s. per quarter so long as the person continues a member; or, in lieu of the annual subscription, a composition of 25 guineas in one payment.

Their design is, to "make faithful records of all the works of nature or art which come within their reach; so that the present as well as future ages may be enabled to put a mark on errors which have been strengthened by long prescription; to restore truths that have been neglected; to push those already known to more various uses; to make the way more passable to what remains unrevealed," &c. To this purpose they have made a great number of experiments and observations on most of the works of nature; and also numbers of short histories of nature, arts, manufactures, useful engines, contrivances, &c. The services which they have rendered to the public are very great. They have improved naval, civil, and military architecture; advanced the security and perfection of navigation; improved agriculture; and put not only this kingdom, but also Ireland, the plantations, &c. upon planting. They have registered experiments, histories, relations, observations, &c. and reduced them into one common stock; and have, from time to time, published those which they reckoned most useful, under the title of *Philosophical Transactions*, &c. and laid the rest up in public registers, to be nakedly transmitted to posterity, as a solid groundwork for future systems.

They have a library adapted to their institution; towards which Mr Henry Howard, afterwards duke of Norfolk, contributed the Norfolcian library, and which is, at this time, greatly increased by a continual series of benefactions. The museum or repository of natural and artificial rarities, given them by Daniel Colwal, Esq. and since enriched by many others, is now removed to the British museum, and makes a part of that great repository. Their motto is *Nullius in verba;* and their place of assembling is Somerset-house in the Strand. Sir Godfrey Copley, baronet, left five guineas to be given annually to the person who should write the best paper in the year, under the head of experimental philosophy. This reward, which is now changed to a gold medal, is the highest honour the society can bestow. It is conferred on St Andrew's day.

2. *The Royal Society of Edinburgh*, was incorporated by royal charter on the 29th of March 1783, and has for its object the cultivation of every branch of science, erudition, and taste. Its rise and progress towards its present state was as follows: In the year 1718 a literary society was established in Edinburgh by the learned Ruddiman and others, which in 1731 was succeeded by a society instituted for the improvement of medical knowledge. In the year 1739 the celebrated Maclaurin conceived the idea of enlarging the plan of this society, by extending it to subjects of philosophy and literature. The institution was accordingly new-modelled by a printed set of laws and regulations, the number of members was increased, and they were distinguished from that time by the title of *The Society for Improving Arts and Sciences*, or more generally by the title of *The Philosophical Society of Edinburgh*. Its meetings, however, were soon interrupted by the disorders of the country during the rebellion in 1745; and they were not renewed till the year 1752. Soon after this period the first volume of the Transactions of the Philosophical Society of Edinburgh was published, under the title of *Essays and Observations, Physical and Literary*, and was followed by other volumes of acknowledged merit. About the end of the year 1782, in a meeting of the professors of the university of Edinburgh, many of whom were likewise members of the Philosophical Society, and warmly attached to its interests, a scheme was proposed by the Rev. Dr Robertson, principal of the university, for the establishment of a new society on a more extended plan, and after the model of some of the foreign academies. It appeared an expedient measure to solicit the royal patronage to an institution of this nature, which promised to be of national importance, and to request an establishment by charter from the crown. The plan was approved and adopted; and the Philosophical Society, joining its influence as a body in seconding the application from the university, his majesty, as we have already observed, was most graciously pleased to incorporate The Royal Society of Edinburgh by charter.

This society consists of ordinary and honorary members; and the honorary places are restricted to persons residing out of Great Britain and Ireland. The election of new members is appointed to be made at two stated general meetings, which are to be held on the fourth Monday of January and the fourth Monday of June. A candidate for the place of an ordinary member must signify by a letter, addressed to one of the members, his wish to be received into the society. He must then be publicly proposed at least a month before the day of election. If the proposal be seconded by two of the members present, his name is to be inserted in the list of candidates, and hung up in the ordinary place of meeting. The election is made by ballot, and is determined in favour of a candidate, if he shall have the votes of two-thirds of those present, in a meeting consisting of at least 21 members. The general business of the society is managed by a president, two vice-presidents, with a council of 12, a general secretary, and a treasurer. These officers are chosen by ballot annually on the last Monday of November. All public deeds, whether of a civil or of a literary nature, are transacted by this board, and proceed in the name of the president or vice-president.

As it was thought that the members would have a greater inducement to punctual attendance on the meetings of the society, if they had some general intimation of the nature of the subjects which were to be considered, and made the topics of conversation, it was therefore resolved to divide the society into two classes, which should meet and deliberate separately. One of these classes is denominated the *Physical Class*, and has for its department the sciences of mathematics, natural philosophy, chemistry, medicine, natural history, and whatever relates to the improvement of arts and manufactures. The other is denominated the *Literary Class*, and has for its department literature, philology, history, antiquities, and speculative philosophy. Every member is desired at his admission to intimate which of those classes he wishes to be more particularly associated with; but he is at the same time intitled to attend the meetings of the other class, and to take part in all its proceedings. Each of the classes has four presidents and two secretaries, who officiate by turns. The meetings of of the phyfical clafs are held on the firft Mondays of January, February, March, April, July, Auguft, November, and December; and the meetings of the Literary clafs are held on the third Mondays of January, February, March, April, June, July, November, and December, at 7 o'clock afternoon.

At thefe meetings the written effays and obfervations of the members of the fociety, or their correfpondents, are read publicly, and become the fubjects of converfation. The fubjects of thefe effays and obfervations are announced at a previous meeting, in order to engage the attendance of thofe members who may be particularly interefted in them. The author of each differtation is likewife defired to furnifh the fociety with an abftract of it, to be read at the next enfuing meeting, when the converfation is renewed with increafed advantage, from the knowledge previoufly acquired of the fubject. At the fame meetings are exhibited fuch fpecimens of natural or artificial curiofities, fuch remains of antiquity, and fuch experiments, as are thought worthy of the attention of the fociety. All objects of natural hiftory prefented to the fociety, are ordered by the charter of the inftitution to be depofited, on receipt, in the mufeum of the univerfity of Edinburgh; and all remains of antiquity, public records, or ancient manufcripts, in the library belonging to the faculty of advocates at Edinburgh.

The ordinary members, whofe ufual refidence is in the city of Edinburgh or its immediate neighbourhood, are expected to attend regularly the monthly meetings; and are required to defray, by an annual contribution, the current expences of the inftitution. The members who refide at fuch a diftance from Edinburgh, that they cannot enjoy the advantages arifing from a regular attendance on the meetings of the fociety, are not fubjected to any contribution for defraying its expences, but have a right to attend thofe meetings when occafionally in Edinburgh, and to take part in all their proceedings.

Five volumes of the Tranfactions of the fociety have been publifhed, which bear ample teftimony to the learning and acutenefs of their various authors.

3. *Medical Society* of London, inftituted in the year 1752, on the plan recommended by Lord Bacon (*De Augm. Scient.* lib. iv. cap. 2.), to revive the Hippocratic method of compofing narratives of particular cafes, in which the nature of the difeafe, the manner of treating it, and the confequences, are to be fpecified; to attempt the cure of thofe difeafes which, in his opinion, have been too boldly pronounced incurable; and, laftly, to extend their inquiries after the powers of particular medicines in the cure of particular cafes; the collections of this fociety have been already publifhed, under the title of *Medical Obfervations and Inquiries*, in feveral volumes.

4. *The Medical Society* of Edinburgh was incorporated by royal charter in 1778; but there appears to have been in that city a voluntary affociation of the fame name from the firft eftablifhment of a regular fchool of phyfic in the univerfity. To the voluntary fociety the public is indebted for fix volumes of curious and ufeful effays, collected principally by the late Dr Monro from June 1731 to June 1736; but in the year 1739 that fociety was united to another, as we have already obferved in a former article. The ordinary members of the prefent medical fociety are elected by ballot, and three diffentients exclude a candidate; an ordinary member may alfo be elected an honorary member, who enjoys the privileges of the others, and receives a diploma, but is freed from the obligation of attendance, delivering papers in rotation, &c. to which the ordinary members are fubject; but in this cafe the votes muft be unanimous. The meetings of this fociety are held every Friday evening (formerly Saturday) in their own hall, during the winter feafon, when papers on medical fubjects are delivered by the feveral members in rotation; and four of thefe are annually elected to fill the chair in rotation, with the title of annual prefidents. This fociety poffeffes an excellent library of books on fubjects connected with its purfuits.

5. The *Royal Medical Society* of Paris was inftituted in 1776. The members are divided into affociates ordinary, limited to 30, honorary to 12, extraordinary to 60, and foreign to 60, and correfpondents. This fociety has publifhed feveral volumes of Memoirs in 4to.

6. *Afiatic Society*, an inftitution planned by the late illuftrious Sir William Jones, and actually formed at Calcutta on the 15th of January 1784, for the purpofe of tracing the hiftory, antiquities, arts, fciences, and literature, of the immenfe continent of Afia. As it was refolved to follow as nearly as poffible the plan of the ROYAL SOCIETY of London, of which the king is *patron*, the patronage of the Afiatic Society was offered to the governor-general and council, as the executive power in the territories of the company. By their acceptance of this offer, Mr Haftings, as governor-general, appeared among the patrons of the new fociety; "but he feemed in his private ftation, as the firft liberal promoter of ufeful knowledge in Bengal, and efpecially as the great encourager of Perfian and Shanfcrit literature, to deferve a particular mark of diftinction:" he was requefted, therefore, to accept the honorary title of prefident. This was handfomely declined in a letter from Mr Haftings, in which he requefted "to yield his pretenfions to the gentleman whofe genius planned the inftitution, and was moft capable of conducting it to the attainment of the great and fplendid purpofes of its formation." On the receipt of this letter, Sir William Jones was nominated prefident of the fociety; and we cannot give the reader a view of the object of the inftitution in clearer language than that which he employed in his firft difcourfe from the chair.

"It is your defign, I conceive (faid the prefident), to take an ample fpace for your learned inveftigations, bounding them only by the geographical limits of Afia; fo that, confidering Hindoftan as a centre, and turning your eyes in idea to the north, you have on your right many important kingdoms in the eaftern peninfula, the ancient and wonderful empire of China with all her Tartarian dependencies, and that of Japan, with the clufter of precious iflands, in which many fingular curiofities have too long been concealed: before you lies that prodigious chain of mountains, which formerly perhaps were a barrier againft the violence of the fea, and beyond them the very interefting country of Tibet, and the vaft regions of Tartary, from which, as from the Trojan horfe of the poets, have iffued fo many confummate warriors, whofe domain has extended at leaft from the banks of the Ilyffus to the mouths of the Ganges: on your left are the beautiful and celebrated provinces of

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of Iran or Persia, the unmeasured and perhaps unmeasurable deserts of Arabia, and the once flourishing kingdom of Yemen, with the pleasant isles that the Arabs have subdued or colonized; and farther westward, the Asiatic dominions of the Turkish sultans, whose moon seems approaching rapidly to its wane. By this great circumference the field of your useful researches will be inclosed; but since Egypt had unquestionably an old connection with this country, if not with China, since the language and literature of the Abyssinians bear a manifest affinity to those of Asia, since the Arabian arms prevailed along the African coast of the Mediterranean, and even erected a powerful dynasty on the continent of Europe, you may not be displeased occasionally to follow the streams of Asiatic learning a little beyond its natural boundary; and, if it be necessary or convenient that a short name or epithet be given to our society, in order to distinguish it in the world, that of *Asiatic* appears both classical and proper, whether we consider the place or the object of the institution, and preferable to *Oriental*, which is in truth a word merely relative, and though commonly used in Europe, conveys no very distinct idea.

"If now it be asked, What are the intended objects of our inquiries within these spacious limits? we answer, MAN and NATURE; whatever is performed by the *one* or produced by the *other*. Human knowledge has been elegantly analysed according to the three great faculties of the mind, *memory*, *reason*, and *imagination*, which we constantly find employed in arranging and retaining, comparing and distinguishing, combining and diversifying, the ideas, which we receive through our senses, or acquire by reflection: hence the three main branches of learning are, *history*, *science*, and *art*; the first comprehends either an account of natural productions, or the genuine records of empires and states, the second embraces the whole circle of pure and mixed mathematics, together with ethics and law, as far as they depend on the reasoning faculty; and the third includes all the beauties of imagery and the charms of invention, displayed in modulated language, or represented by colour, figure, or sound.

"Agreeably to this analysis, you will investigate whatever is rare in the stupendous fabric of nature, will correct the geography of Asia by new observations and discoveries; will trace the annals and even traditions of those nations who from time to time have peopled or desolated it; and will bring to light their various forms of government, with their institutions civil and religious; you will examine their improvements and methods in arithmetic and geometry; in trigonometry, mensuration, mechanics, optics, astronomy, and general physics; their systems of morality, grammar, rhetoric, and dialectic; their skill in chirurgery and medicine; and their advancement, whatever it may be, in anatomy and chemistry. To this you will add researches into their agriculture, manufactures, trade; and whilst you inquire with pleasure into their music, architecture, painting, and poetry, will not neglect those inferior arts by which the comforts and even elegancies of social life are supplied or improved. You may observe, that I have omitted their languages, the diversity and difficulty of which are a sad obstacle to the progress of useful knowledge; but I have ever considered languages as the mere instruments of real learning, and think them improperly confounded with learning itself: the attainment of them is, however, indispensably necessary; and if to the Persian, Armenian, Turkish, and Arabic, could be added not only the Shanscrit, the treasures of which we may now hope to see unlocked, but even the Chinese, Tartarian, Japanese, and the various insular dialects, an immense mine would then be open, in which we might labour with equal delight and advantage."

Of this society three volumes of the Transactions have been published, which are replete with information in a high degree curious and important; and we hope that the European world shall soon be favoured with another. The much-to-be-lamented death of the accomplished president may indeed damp the spirit of investigation among the members; for to conquer difficulties so great as they must meet with, a portion seems to be necessary of that enthusiasm which accompanied all the pursuits of Sir William Jones; but his successor is a man of great worth and learning, and we trust will use his utmost endeavours to have the plan completed of which Sir William gave the outlines.

5. *The American Philosophical Society*, held at Philadelphia, was formed in January 1769 by the union of two societies which had formerly subsisted in that city. This society extends its attention to geography, mathematics, natural philosophy, and astronomy; medicine and anatomy; natural history and chemistry; trade and commerce; mechanics and architecture; husbandry and American improvements. Its officers are a patron, president, three vice-presidents, one treasurer, four secretaries, and three curators, who are annually chosen by ballot. The duty of the president, vice-presidents treasurer, and secretaries, is the same as in other societies. The business of the curators is to take the charge of all specimens of natural productions, whether of the animal, vegetable, or fossil kingdom; all models of machines and instruments; and all other matters belonging to the society which shall be intrusted to them. The ordinary meetings are held on the first and third Fridays of every month from October to May inclusive. This society was incorporated by charter 15th March 1780; and has published three volumes of its Transactions, containing many ingenious papers on general literature and the sciences, as well as respecting those subjects peculiar to America. It is a delightful prospect to the philosopher to consider, that Asia, Europe, and America, though far separated and divided into a variety of political states, are all three combined to promote the cause of knowledge and truth.

6. *A Literary and Philosophical Society* of considerable reputation has been lately established at Manchester, under the direction of two presidents, four vice-presidents, and two secretaries. The number of members is limited to 50; besides whom there are several honorary members, all of whom are elected by ballot; and the officers are chosen annually in April. Five volumes of valuable essays have been already published by this society.

A society on a similar plan has been established at Newcastle. It is composed of a number of most respectable members, and possesses a very valuable library and philosophical apparatus. Lectures on the different branches of natural philosophy have been delivered for several years at this institution.

7. *Society for Promoting the Discovery of the Interior Parts*

Parts of Africa. This society or association for exploring the internal districts of Africa, of which so little is at present known, was formed in London by some opulent individuals in 1788; who, strongly impressed with a conviction of the practicability and utility of thus enlarging the fund of human knowledge, determined if possible to rescue the age from that stigma which attaches to its ignorance of so large and so near a portion of the globe. The founders of this society resolved to admit no man a member for a shorter period than three years, during which he must pay annually into the public fund five guineas. After three years, any member, upon giving a year's notice, may withdraw himself from the association. During the first 12 months each of the members was allowed to recommend for the approbation of the society such of his friends as he might think proper to be admitted into it; but since that period we believe all additional members have been elected by a ballot of the association at large. A committee was chosen by ballot to manage the funds of the society, to choose proper persons to be sent on the discovery of the interior parts of Africa, and to carry on the society's correspondence, with express injunctions to disclose no intelligence received from their agents but to the society at large. But a fuller account of the nature of this establishment, and the very happy efforts they have made, may be seen in the superb edition of their proceedings printed in 1790, 4to, for their own use; or in the 8vo edition since made public. They soon found two gentlemen, Mr Lucas and Mr Ledyard, who were singularly well qualified for the important mission. The information they have acquired will be found in the above work; with a new map by Mr Rennel, exhibiting the geographical knowledge collected by the African association. Mr Ledyard very unfortunately died during his researches at Cairo.

Few of our readers are unacquainted with the travels of Mr Park under the patronage of the society. For an account of which see AFRICA. A second journey was undertaken by the same gentleman within these three years; but as he has not been heard of for a long time, the most serious apprehensions are entertained that he and his companions have fallen victims either to the inhospitable climate, or to the watchful jealousy of the Moors. Another enterprising traveller, Mr Horneman, was sent out by the suciety about 1800. He departed from Cairo with a caravan, and reached Mourzouk, a place situated south from Tripoli; and from thence sent a communication to his constituents which has since been published by the society. This is the last account that was received of this traveller, from which it is feared that he has also perished.

8. *The Society of Antiquaries of London*, was founded about the year 1572 by Archbishop Parker, a munificent patron of learned men. For the space of 20 years it assembled in the house of Sir Robert Cotton; in 1589 they resolved to apply to Queen Elizabeth for a charter and a public building where they might hold their meetings; but it is uncertain whether any such application was ever made. In the mean time, the reputation of the society gradually increased, and at length it excited the jealousy of James I. who was afraid lest it should presume to canvass the secret transactions of his government. He accordingly dissolved it. But in the beginning of the last century, the Antiquarian society began to revive; and a number of gentlemen, eminent for their affection to this science, had weekly meetings, in which they examined the antiquities and history of Great Britain preceding the reign of James I. but without excluding any other remarkable antiquities that might be offered to them. From this time the society grew in importance; and in 1750 they unanimously resolved to petition the king for a charter of incorporation. This they obtained the year following, by the influence of the celebrated earl of Hardwicke, then lord-chancellor, and Martin Folkes, Esq; who was then their president. The king declared himself their founder and patron, and empowered them to have a body of statutes, and a common seal, and to hold in perpetuity lands, &c. to the yearly value of 1000l.

The chief object of the inquiries and researches of the society are British antiquities and history; not, however, wholly excluding those of other countries. It must be acknowledged, that the study of antiquity offers to the curious and inquisitive a large field for research and amusement. The inquirer in this branch furnishes the historian with his best materials, while he distinguishes from truth the fictions of a bold invention, and ascertains the credibility of facts; and to the philosopher he presents a fruitful source of ingenious speculation, while he points out to him the way of thinking, and the manners of men, under all the varieties of aspect in which they have appeared.

An antiquarian ought to be a man of solid judgement, possessed of learning and science, that he may not be an enthusiastic admirer of every thing that is ancient merely because it is ancient; but be qualified to distinguish between those researches which are valuable and important, and those which are trifling and useless. It is from the want of these qualifications that some men have contracted such a blind passion for every thing that is ancient, that they have exposed themselves to ridicule, and their study to contempt. But if a regard to utility were always to regulate the pursuits of the antiquarian, the shafts of satire would no longer be levelled at him; but he would be respected as the man who labours to restore or to preserve such ancient productions as are suited to illuminate religion, philosophy, and history, or to improve the arts of life.

We by no means intend to apply these observations to any particular society of antiquarians; but we throw them out, because we know that an assiduous study of antiquity is apt, like the ardent pursuit of money, to lose sight of its original object, and to degenerate into a passion which mistakes the mean for the end, and considers possession without a regard to utility as enjoyment.

An association similar to that of the Antiquarian Society of London was founded in *Edinburgh* in 1780, and received the royal charter in 1783. A volume of the transactions of this society has been published; but with the exception of two or three memoirs, it contains little worthy of notice; and accordingly, it has never attracted the attention of the public.

Besides these literary societies here mentioned, there are a great number more in different parts of Europe, some of which are noticed under the article ACADEMY. Those which are omitted are not omitted on account of any idea of their inferior importance; but either because

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caufe we have had no accefs to authentic information, or becaufe they refemble the focieties already defcribed fo clofely, that we could have given nothing but their names.

III. Societies for Encouraging and Promoting Arts, Manufactures, &c.

1. *London Society for the Encouragement of Arts, Manufactures, and Commerce*, was inftituted in the year 1754 by Lord Folkftone, Lord Romney, Dr Stephen Hales, and a few private gentlemen; but the merit of this inftitution chiefly belonged to Mr William Shipley, an ingenious mechanic; who, though deriving no advantages from learning, by unwearied perfonal attendance found means to engage a few perfons of rank and fortune to meet at Peele's coffeehoufe in Fleet-ftreet, and to adopt a plan for promoting arts and manufactures.

The office-bearers of this fociety are a prefident, 12 vice-prefidents, a fecretary, and regifter. Their proceedings are regulated by a body of rules and orders eftablifhed by the whole fociety, and printed for the ufe of the members. All queftions and debates are determined by the holding up of hands, or by ballot if required; and no matter can be confirmed without the affent of a majority at two meetings. They invite all the world to propofe fubjects for encouragement; and whatever is deemed deferving of attention is referred to the confideration of a committee, which, after due inquiry and deliberation, make their report to the whole fociety, where it is approved, rejected, or altered. A lift is printed and publifhed every year of the matters for which they propofe to give premiums; which premiums are either fums of money, and thofe fometimes very confiderable ones; or the fociety's medal in gold or filver, which they confider as the greateft honour they can beftow. All poffible care is taken to prevent partiality in the diftribution of their premiums, by defiring the claimants names to be concealed, and by appointing committees, (who when they find occafion call to their affiftance the moft fkilful artifts) for the ftrict examination of the real merit of all matters and things brought before them, in confequence of their premiums.

The chief objects of the attention of the Society for the Encouragement of Arts, Manufactures, and Commerce, in the application of their revenues, are ingenuity in the feveral branches of the polite and liberal arts, ufeful difcoveries and improvements in agriculture, manufactures, mechanics, and chemiftry, or the laying open of any fuch to the public; and, in general, all fuch ufeful inventions, difcoveries, or improvements (though not mentioned in the book of premiums) as may appear to have a tendency to the advantage of trade and commerce.

The following are fome of the moft important regulations of this fociety. It is required that the matters for which premiums are offered be delivered in without names, or any intimation to whom they belong; that each particular thing be marked in what manner each claimant thinks fit, fuch claimant fending with it a paper fealed up, having on the outfide a correfponding mark, and on the infide the claimant's name and addrefs; and all candidates are to take notice, that no claim for a premium will be attended to, unlefs the conditions of the advertifement are fully complied with. No papers fhall be opened but fuch as fhall gain premiums, unlefs where it appears to the fociety abfolutely neceffary for the determination of the claim: all the reft fhall be returned unopened, with the matters to which they belong, if inquired after by the marks within two years; after which time, if not demanded, they fhall be publicly burnt unopened at fome meeting of the fociety. All the premiums of this fociety are defigned for that part of Great Britain called England, the dominion of Wales, and the town of Berwick upon Tweed, unlefs exprefsly mentioned to the contrary. No perfon fhall receive any premium, bounty, or encouragement, from the fociety for any matter for which he has obtained or propofes to obtain a patent. No member of this fociety fhall be a candidate for or intitled to receive any premium, bounty, or reward whatever, except the honorary medal of the fociety.

The refpectability of the members who compofe it may be feen by perufing the lift which generally accompanies thetr tranfactions. In the laft volume (vol. xii.) it occupies no lefs than 43 pages. Some idea may be formed of the wealth of this fociety, by obferving that the lift of their premiums fills 96 pages, and amounts to 250 in number. Thefe confift of gold medals worth from 30 to 50, and in a few inftances to 100 guineas; and filver medals valued at 10 guineas.

This fociety is one of the moft important in Great Britain. Much money has been expended by it, and many are the valuable effects of which it has been productive. Among thefe we reckon not only the difcoveries which it has excited, but the inftitution of other focieties on the fame principles to which it has given birth; and we do not hefitate to conclude, that future ages will confider the founding of this fociety as one of the moft remarkable epochs in the hiftory of the arts. We contemplate with pleafure the beneficial effects which muft refult to this nation and to mankind by the diffufion of fuch inftitutions; and rejoice in the hope that the active minds of the people of Great Britain, inftead of being employed as formerly in controverfies about religion, which engender ftrife, or in difcuffions concerning the theory of politics, which lead to the adoption of fchemes inconfiftent with the nature and condition of man, will foon be more generally united into affociations for promoting ufeful knowledge and folid improvement, and for alleviating the diftreffes of their fellow creatures.

1. *Society inftituted at Bath for the Encouragement of Agriculture, Arts, Manufactures, and Commerce.* It was founded in the year 1777 by feveral gentlemen who met at the city of Bath. This fcheme met with a very favourable reception both from the wealthy and learned. The wealthy fubfcribed very liberally, and the learned communicated many important papers. On application to the London and provincial focieties inftituted for the like purpofes, they very politely offered their affiftance. Seven volumes of their tranfactions have already been publifhed, containing very valuable experiments and obfervations, particularly refpecting agriculture, which well deferve the attention of all farmers in the kingdom. We have confulted them with much fatisfaction on feveral occafions, and have frequently referred to them in the courfe of this work; and therefore, with pleafure,

embrace

embrace the present opportunity of repeating our obligations. We owe the same acknowledgments to the Society for the Improvement of Arts, &c. of London.

3. *Society for working Mines*, an association lately formed on the continent of Europe. This institution arose from the accidental meeting of several mineralogists at Skleno near Schemnitz in Hungary, who were collected in order to examine a new method of amalgamation. Struck with the shackles imposed on mineralogy by monopolizers of new and useful processes, they thought no method so effectual to break them, as forming a society, whose common labours should be directed to fix mining on its surest principles; and whose memoirs, spread all over Europe, might offer to every adventurer the result of the researches, of which they are the object. By these means they supposed, that there would be a mass of information collected; the interests of individuals would be lost in the general interest; and the one would materially assist the other. Imposture and quackery would, by the same means, be banished from a science, which must be improved by philosophy and experience; and the society, they supposed, would find, in the confidence which they inspired, the reward and the encouragement of their labours. They design, that the memoirs which they publish shall be short and clear; truth must be their basis, and every idle discussion, every foreign digression, must be banished; politics and finance must be avoided, though the dissertations may seem to lead towards them; and they oblige themselves to oppose the affectation of brilliancies, and the ostentation of empty speculation, when compared with plain, simple, and useful facts.

The object of the society is physical geography; mineralogy founded on chemistry; the management of ore in the different operations which it undergoes; subterraneous geometry; the history of mining; founderies, and the processes for the extraction of metals from the ores, either by fusion or amalgamation, in every instance applied to practice. The end of this institution is to collect, in the most extensive sense, every thing that can assist the operations of the miner, and to communicate it to the different members, that they may employ it for the public good, in their respective countries. Each member must consider himself as bound to send to the society every thing which will contribute to the end of its institution; to point out, with precision, the several facts and observations; to communicate every experiment which occurs, even the unsuccessful ones, if the relation may seem to be advantageous to the public; to communicate to the society their examination of schemes, and their opinions on questions proposed by it; and to pay annually two ducats (about 18s. 6d.) to the direction every Easter. The society, on the other hand, is bound to publish every novelty that shall be communicated to it; to communicate to each member, at the member's expence, the memoirs, designs, models, productions, and every thing connected with the institution; to answer all the necessary demands made, relating in any respect to mining; and to give its opinion on every plan or project communicated through the medium of an honorary member.

The great centre of all intelligence is to be at Zellerfeld in Hartz, Brunswick: but the society is not fixed to any one spot; for every particular state some practical mineralogist is nominated as director. Among these are the names of Baron Born, M. Pallas, M. Charpentier, M. Prebra, and M. Henkel. Their office is to propose the members; to take care that the views of the society are pursued in the different countries where they reside; to answer the requests of the members of their country who are qualified to make them; in case of the death of a director, to choose another; and the majority is to determine where the archives and the strong box is to be placed.

All the eminent mineralogists in Europe are members of this society. It is erected on so liberal and so extensive a plan, that we entertain the highest hopes of its success; and have only to add, that we wish much to see the study of several other sciences pursued in the same manner.

4. *The Society for the Improvement of Naval Architecture*, was founded in 1791. The object of it is to encourage every useful invention and discovery relating to naval architecture as far as shall be in their power, both by honorary and pecuniary rewards. They have in view particularly to improve the theories of floating bodies and of the resistance of fluids; to procure draughts and models of different vessels, together with calculations of their capacity, centre of gravity, tonnage, &c.; to make observations and experiments themselves, and to point out such observations and experiments as appear best calculated to further their designs, and most deserving those premiums which the society can bestow. But though the improvement of naval architecture in all its branches be certainly the principal object of this institution, yet the society do not by any means intend to confine themselves merely to the form and structure of vessels. Every subordinate and collateral pursuit will claim a share of the attention of the society in proportion to its merits; and whatever may have any tendency to render navigation more safe, salutary, and even pleasant, will not be neglected.

This institution owes its existence to the patriotic disposition and extraordinary attention of Mr Sewel a private citizen of London, who (though engaged in a line of business totally opposite to all concerns of this kind) has been led, by mere accident, to take such ocular notice of, and make such observations on, the actual state of naval architecture in this country, as naturally occurred to a man of plain understanding, zealous for the honour and interest of his country, and willing to bestow a portion of that time for the public good, which men of a different description would rather have devoted to their own private advantage. His attention was the more seriously excited, by finding that it was the opinion of some private ship-builders, who, in a debate on the failure of one of our naval engagements, pronounced, that such "would ever be the case while that business (the construction of our ships of war) was not studied as a science, but carried on merely by precedent; that there had not been one improvement in our navy that did not originate with the French, who had naval schools and seminaries for the study of it; and that our ships were not a match for those of that nation either singly or in a fleet, &c. &c."

In a short time the society were enabled to offer very considerable premiums for particular improvements in the construction of our shipping, &c. &c. and also to encourage our philosophers, mathematicians, and mechanics, to make satisfactory experiments, tending to ascertain

certain the laws of resistance of water to solids of different forms, in all varieties of circumstance. On this head the reward is not less than one hundred pounds or a gold medal. Other premiums of 50, 30, and 20 guineas, according to the importance or difficulty of the particular subject or point of investigation, are likewise offered, for different discoveries, inventions, or improvements. The terms of admission into the society are a subscription of two guineas annually, or twenty guineas for life.

5. *Society of Artists of Great Britain*, which consists of directors and fellows, was incorporated by charter in 1765, and empowered to purchase and hold lands, not exceeding 1000l. a-year. The directors of this society, annually elected, are to consist of 24 persons, including the president, vice-president, treasurer, and secretary; and it is required that they be either painters, sculptors, architects, or engravers by profession.

6. *British Society for Extending the Fisheries and Improving the Sea-Coasts of this Kingdom*, was instituted in 1786. The end and design of this society will best appear from their charter, of which we present an abstract.

The preamble states, "the great want of improvement in fisheries, agriculture, and manufactures, in the Highlands and Islands of North Britain; the prevalence of emigration from the want of employment in those parts; the prospect of a new nursery of seamen, by the establishment of fishing towns and villages in that quarter. The act therefore declares, that the persons therein named, and every other person or persons who shall thereafter become proprietors of the joint stock mentioned therein, shall be a distinct and separate body politic and corporate, by the name of *The British Society for Extending the Fisheries and Improving the Sea-coasts of this Kingdom*: That the said society may raise a capital joint stock not exceeding 150,000l. to be applied to purchasing or otherwise acquiring lands and tenements in perpetuity, for the building thereon, and on no other land whatever, free towns, villages, and fishing stations: That the joint stock shall be divided into shares of 50l. each: That no one person shall in his or her name possess more than ten shares, or 500l.: That the society shall not borrow any sum or sums of money whatsoever: That the sums to be advanced for this undertaking, and the profits arising therefrom, shall be divided proportionally to the sum subscribed; and that no person shall be liable for a larger sum than he or she shall have respectively subscribed: That one or two shares shall intitle to one vote and no more, in person or by proxy, at all meetings of proprietors; three or four shares to two votes; five, six, or seven shares, to three votes; eight or nine shares to four votes; and ten shares to five votes and no more: That more persons than one inclining to hold in their joint names one or more shares shall be intitled to vote, by one of such persons, according to the priority of their names, or by proxy: That bodies corporate shall vote by proxy under their seal: That all persons holding proxies shall be proprietors, and that no one person shall hold more than five votes by proxy: That the affairs of the society shall be managed by a governor, deputy governor, and 13 other directors, to be elected annually on the 25th of March, from among the proprietors of the society, holding at least one full share, by signed lists of their names to be transmitted by the proprietors to the secretary of the society: that five proprietors, not being governor, director, or other officer, shall be in like manner annually elected to audit the accounts of the society: That there shall be one general meeting of the proprietors annually on the 25th of March: That occasional general meetings shall be called on the request of nine or more proprietors: That the general meetings of the proprietors shall make all bye-laws and constitutions for the government of the society, and for the good and orderly carrying on of the business of the same: That no transfer shall be made of the stock of the society for three years from the 10th of August 1786: That the cash of the society shall be lodged in the bank of England, bank of Scotland, or the royal bank of Scotland: That no director, proprietor, agent, or officer of the society, shall retain any sum or sums of money in his hands beyond the space of 30 days, on any account whatsoever: That all payments by the society shall be made by drafts on the said banks, under the hands of the governor or deputy-governor, countersigned by the secretary or his deputy, and two or more directors: And that the books in which the accounts of the society shall be kept shall be open to all the proprietors."

The institution of this public-spirited society was in a great measure owing to the exertions of the patriotic John Knox; who, in the course of 23 years, traversed and explored the Highlands of Scotland not fewer than 16 times, and expended several thousand pounds of his own fortune in pursuing his patriotic designs.

7. *British Wool Society*. See *British* WOOL *Society*.

SOCIETY Isles, a cluster of isles, so named by Captain Cook in 1769. They are situated between the latitudes of 16. 10. and 16. 55. south, and between the longitudes of 150. 57. and 152. west. They are eight in number; namely, Otaheite, Huaheine, Ulietea, Otaha, Bolabola, Maurua, Tooboua, and Tabooyamanoo or Saunders's Island. The soil, productions, people, their language, religion, customs, and manners, are so nearly the same as at OTAHEITE, that little need be added here on that subject. Nature has been equally bountiful in uncultivated plenty, and the inhabitants are as luxurious and as indolent. A plantain branch is the emblem of peace, and exchanging names the greatest token of friendship. Their dances are more elegant, their dramatic entertainments have something of plot and consistency, and they exhibit temporary occurrences as the objects of praise or satire; so that the origin of ancient comedy may be already discerned among them. The people of Huaheine are in general stouter and fairer than those of Otaheite, and this island is remarkable for its populousness and fertility. Those of Ulietea, on the contrary, are smaller and blacker, and much less orderly. Captain Cook put on shore a Cape ewe at Bolabola, where a ram had been left by the Spaniards; and also an English boar and sow, with two goats, at Ulietea. If the valuable animals which have been transported thither from Europe should be suffered to multiply, no part of the world will equal these islands in variety and abundance of refreshments for future navigators.

SOCINIANS, in *Church-History*, a sect of Christian heretics, so called from their founder Faustus Socinus (see SOCINUS). They maintain, "That Jesus Christ was a mere man, who had no existence before he was conceived by the Virgin Mary; that the Holy Ghost is

Socinians, Socinus.

no distinct person, but that the Father is truly and properly God. They own, that the name of God is given in the Holy Scriptures to Jesus Christ; but contend, that it is only a deputed title, which, however, invests him with an absolute sovereignty over all created beings, and renders him an object of worship to men and angels. They deny the doctrines of satisfaction and imputed righteousness; and say that Christ only preached the truth to mankind, set before them in himself an example of heroic virtue, and sealed his doctrines with his blood. Original sin and absolute predestination they esteem scholastic chimeras. They likewise maintain the sleep of the soul, which they say becomes insensible at death, and is raised again with the body at the resurrection, when the good shall be established in the possession of eternal felicity, while the wicked shall be consigned to a fire that will not torment them eternally, but for a certain duration in proportion to their demerits."

This sect has long been indignant at being styled *Socinians*. They disclaim every human leader; and professing to be guided solely by the word of God and the deductions of reason, they call themselves *Unitarians*, and affect to consider all other Christians, even their friends the Arians, as *Polytheists*. Modern Unitarianism, as taught by Dr Priestley, is, however, a very different thing from Socinianism, as we find it in the Racovian catechism and other standard works of the sect. This far-famed philosopher has discovered, what escaped the sagacity of all the *fratres poloni*, that Jesus Christ was the son of Joseph as well as Mary; that the evangelists mistook the meaning of Isaiah's prophecy, that "a virgin should conceive and bear a son;" that the applying of this prophecy to the birth of our Saviour, led them to conclude that his conception was miraculous; and that we are not to wonder at this mistake, as the apostles were not always inspired, and were in general inconclusive reasoners. The modesty of the writer in claiming the merit of such discoveries will appear in its proper colours to all our readers: the truth of his doctrine shall be considered in another place. See THEOLOGY.

SOCINUS, LÆLIUS, the first author of the sect of the Socinians, was born at Sienna in Tuscany in 1525. Being designed by his father for the law, he began very early to search for the foundation of that science in the Word of God; and by that study discovered that the Romish religion taught many things contrary to revelation; when, being desirous of penetrating farther into the true sense of the Scriptures, he studied Greek, Hebrew, and even Arabic. In 1547 he left Italy, to go and converse with the Protestants; and spent four years in travelling through France, England, the Netherlands, Germany, and Poland, and at length settled at Zurich. He by this means became acquainted with the most learned men of his time, who testified by their letters the esteem they had for him: but as he discovered to them his doubts, he was greatly suspected of heresy. He, however, conducted himself with such address, that he lived among the capital enemies of his opinions, without receiving the least injury. He met with some disciples, who heard his instructions with respect; these were Italians who left their native country on account of religion, and wandered about in Germany and Poland. He communicated likewise his sentiments to his relations by his writings, which he caused to be conveyed to them at Sienna. He died at Zurich in 1562. Those who were of sentiments opposite to his, and were personally acquainted with him, confess that his outward behaviour was blameless. He wrote a Paraphrase on the first chapter of St John; and other works are ascribed to him.

Socinus.

SOCINUS, *Faustus*, nephew of the preceding, and principal founder of the Socinian sect, was born at Sienna in 1539. The letters which his uncle Lælius wrote to his relations, and which infused into them many seeds of heresy, made an impression upon him; so that, knowing himself not innocent, he fled as well as the rest when the inquisition began to persecute that family. He was at Lyons when he heard of his uncle's death, and departed immediately to take possession of his writings. He returned to Tuscany; and made himself so agreeable to the grand duke, that the charms which he found in that court, and the honourable posts he filled there, hindered him for twelve years from remembering that he had been considered as the person who was to put the last hand to the system of samosatenian divinity, of which his uncle Lælius had made a rough draught. At last he went into Germany in 1574, and paid no regard to the grand duke's advices to return. He staid three years at Basil, and studied divinity there, and having adopted a set of principles very different from the system of Protestants, he resolved to maintain and propagate them; for which purpose he wrote a treatise *De Iesu Christo Servatore*. In 1579 Socinus retired into Poland, and desired to be admitted into the communion of the Unitarians; but as he differed from them in some points, on which he refused to be silent, he met with a repulse. However, he did not cease to write in defence of their churches against those who attacked them. At length his book against James Paleologus furnished his enemies with a pretence to exasperate the king of Poland against him; but though the mere reading of it was sufficient to refute his accusers, Socinus thought proper to leave Cracow, after having resided there four years. He then lived under the protection of several Polish lords, and married a lady of a good family; but her death, which happened in 1587, so deeply afflicted him as to injure his health; and to complete his sorrow, he was deprived of his patrimony by the death of Francis de Medicis great duke of Florence. The consolation he found in seeing his sentiments at last approved by several ministers, was greatly interrupted in 1598; for he met with a thousand insults at Cracow, and was with great difficulty saved from the hands of the rabble. His house was plundered, and he lost his goods; but this loss was not so uneasy to him as that of some manuscripts, which he extremely regretted. To deliver himself from such dangers, he retired to a village about nine miles distant from Cracow, where he spent the remainder of his days at the house of Abraham Blonski, a Polish gentleman, and died there in 1604. All Faustus Socinus's works are contained in the two first volumes of the *Bibliotheca Fratrum Polonorum*.

SOCMANS, SOKEMANS, or *Socmen (Socmanni)*, are such tenants as hold their lands and tenements by socage tenure. See SOCAGE.

SOCOTORA, an island lying between Asia and Arabia Felix; about 50 miles in length, and 22 in breadth. It is particularly noted for its fine aloes, known by the name of *Socotrine ALOES*. The religion of the natives

natives is a mixture of Mahometanism and Paganism; but they are civil to strangers who call there in their passage to the East Indies. It abounds in fruit and cattle; and they have a king of their own, who is dependent on Arabia.

SOCRATES, the greatest of the ancient philosophers, was born at Alopece, a village near Athens, in the fourth year of the 77th olympiad. His parents were of low rank; his father Sophroniscus being a statuary, and his mother Phænareta a midwife. Sophroniscus brought up his son, contrary to his inclination, in his own manual employment; in which Socrates, though his mind was continually aspiring after higher objects, was not unsuccessful, for whilst he was a young man, he is said to have formed statues of the habited Graces, which were allowed a place in the citadel of Athens. Upon the death of his father he was left in such straitened circumstances as laid him under the necessity of exercising that art to procure the means of subsistence, though he devoted, at the same time, all the leisure which he could command to the study of philosophy. His distress, however, was soon relieved by Crito, a wealthy Athenian; who, remarking his strong propensity to study, and admiring his ingenuous disposition and distinguished abilities, generously took him under his patronage, and intrusted him with the instruction of his children. The opportunities which Socrates by this means enjoyed of attending the public lectures of the most eminent philosophers, so far increased his thirst after wisdom, that he determined to relinquish his occupation, and every prospect of emolument which that might afford, in order to devote himself entirely to his favourite pursuits. Under Anaxagoras and Archelaus he prosecuted the study of nature in the usual manner of the philosophers of the age, and became well acquainted with their doctrines. Prodicus the sophist was his preceptor in eloquence, Evenus in poetry, Theodorus in geometry, and Damo in music. Aspasia, a woman no less celebrated for her intellectual than her personal accomplishments, whose house was frequented by the most celebrated characters, had also some share in the education of Socrates. Under such preceptors it cannot reasonably be doubted but that he became master of every kind of learning which the age in which he lived could afford; and being blessed with very uncommon talents by nature, he appeared in Athens, under the respectable characters of a good citizen and a true philosopher. Being called upon by his country to take arms in the long and severe struggle between Athens and Sparta, he signalized himself at the siege of Potidæa, both by his valour and by the hardiness with which he endured fatigue. During the severity of a Thracian winter, whilst others were clad in furs, he wore only his usual clothing, and walked barefoot upon the ice. In an engagement in which he saw ALCIBIADES falling down wounded, he advanced to defend him, and saved both him and his arms: and though the prize of valour was on this occasion unquestionably due to Socrates, he generously gave his vote that it might be bestowed upon Alcibiades, to encourage his rising merit. He served in other campaigns with distinguished bravery, and had the happiness on one occasion to save the life of Xenophon, by bearing him, when covered with wounds, out of the reach of the enemy.

It was not till Socrates was upwards of 60 years of age that he undertook to serve his country in any civil office, when he was chosen to represent his own district, in the senate of five hundred. In this office, though he at first exposed himself to some degree of ridicule from the want of experience in the forms of business, he soon convinced his colleagues that he was superior to them all in wisdom and integrity. Whilst they, intimidated by the clamours of the populace, passed an unjust sentence of condemnation upon the commanders, who, after the engagement at the Arginusian islands, had been prevented by a storm from paying funeral honours to the dead, Socrates stood forth singly in their defence, and to the last refused to give his suffrage against them, declaring that no force should compel him to act contrary to justice and the laws. Under the subsequent tyranny he never ceased to condemn the oppressive and cruel proceedings of the thirty tyrants; and when his boldness provoked their resentment, so that his life was in hazard, fearing neither treachery nor violence, he still continued to support with undaunted firmness the rights of his fellow citizens.

Having given these proofs of public virtue both in a military and civil capacity, he wished to do still more for his country. Observing with regret how much the opinions of the Athenian youth were misled, and their principles and taste corrupted by philosophers who spent all their time in refined speculations upon nature and the origin of things, and by sophists who taught in their schools the arts of false eloquence and deceitful reasoning; Socrates formed the wise and generous design of instituting a new and more useful method of instruction. He justly conceived the true end of philosophy to be, not to make an ostentatious display of superior learning and ability in subtle disputations or ingenious conjectures, but to free mankind from the dominion of pernicious prejudices; to correct their vices; to inspire them with the love of virtue; and thus conduct them in the path of wisdom to true felicity. He therefore assumed the character of a moral philosopher; and, looking upon the whole city of Athens as his school, and all who were disposed to lend him their attention as his pupils, he seized every occasion of communicating moral wisdom to his fellow citizens. He passed the greater part of his time in public; and the method of instruction of which he chiefly made use was, to propose a series of questions to the person with whom he conversed, in order to lead him to some unforeseen conclusion. He first gained the consent of his respondent to some obvious truths, and then obliged him to admit others from their relation or resemblance to those to which he had already assented. Without making use of any direct argument or persuasion, he chose to lead the person he meant to instruct, to deduce the truths of which he wished to convince him, as a necessary consequence from his own concessions. He commonly conducted these conferences with such address, as to conceal his design till the respondent had advanced too far to recede. On some occasions he made use of ironical language, that vain men might be caught in their own replies, and be obliged to confess their ignorance. He never assumed the air of a morose and rigid preceptor, but communicated useful instruction with all the ease and pleasantry of polite conversation. Though eminently furnished with every kind of learning, he preferred moral to speculative wisdom. Convinced that philosophy

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losophy is valuable, not as it furnishes questions for the schools, but as it provides men with a law of life, he censured his predecessors for spending all their time in abstruse researches into nature, and taking no pains to render themselves useful to mankind. His favourite maxim was, Whatever is above us doth not concern us. He estimated the value of knowledge by its utility, and recommended the study of geometry, astronomy, and other sciences, only so far as they admit of a practical application to the purposes of human life. His great object in all his conferences and discourses was, to lead men into an acquaintance with themselves; to convince them of their follies and vices; to inspire them with the love of virtue; and to furnish them with useful moral instructions. Cicero might therefore very justly say of Socrates, that he was the first who called down philosophy from heaven to earth, and introduced her into the public walks and domestic retirements of men, that she might instruct them concerning life and manners.

Through his whole life this good man discovered a mind superior to the attractions of wealth and power. Contrary to the general practice of the preceptors of his time, he instructed his pupils without receiving from them any gratuity. He frequently refused rich presents, which were offered him by Alcibiades and others, though importunately urged to accept them by his wife. The chief men of Athens were his stewards: they sent him in provisions, as they apprehended he wanted them; he took what his present wants required, and returned the rest. Observing the numerous articles of luxury which were exposed to sale in Athens, he exclaimed, "How many things are there which I do not want!" With Socrates, moderation supplied the place of wealth. In his clothing and food, he consulted only the demands of nature. He commonly appeared in a neat but plain cloak, with his feet uncovered. Though his table was only supplied with simple fare, he did not scruple to invite men of superior rank to partake of his meals; and when his wife, upon some such occasion, expressed her dissatisfaction on being no better provided, he desired her to give herself no concern; for if his guests were wise men, they would be contented with whatever they found at his table; if otherwise, they were unworthy of notice. Whilst others, says he, live to eat, wise men eat to live.

Though Socrates was exceedingly unfortunate in his domestic connection, he converted this infelicity into an occasion of exercising his virtues. Xantippe, concerning whose ill humour ancient writers relate many amusing tales, was certainly a woman of a high and unmanageable spirit. But Socrates while he endeavoured to curb the violence of her temper, improved his own. When Alcibiades expressed his surprise that his friend could bear to live in the same house with so perverse and quarrelsome a companion, Socrates replied, that being daily inured to ill humour at home, he was the better prepared to encounter perverseness and injury abroad.

In the midst of domestic vexations and public disorders, Socrates retained such an unruffled serenity, that he was never seen either to leave his own house or to return home with a disturbed countenance. In acquiring this entire dominion over his passions and appetites, he had the greater merit, as it was not effected without a violent struggle against his natural propensities. Zopyrus, an eminent physiognomist, declared, that he discovered in the features of the philosopher evident traces of many vicious inclinations. The friends of Socrates who were present ridiculed the ignorance of this pretender to extraordinary sagacity. But Socrates himself ingenuously acknowledged his penetration, and confessed that he was in his natural disposition prone to vice, but that he had subdued his inclinations by the power of reason and philosophy.

Through the whole of his life Socrates gave himself up to the guidance of unbiassed reason, which is supposed by some to be all that he meant by the genius or *dæmon* from which he professed to receive instruction. But this opinion is inconsistent with the accounts given by his followers of that dæmon, and even with the language in which he spoke of it himself. Plato sometimes calls it his *guardian*, and Apuleius his *god;* and as Xenophon attests that it was the belief of his master that the gods occasionally communicate to men the knowledge of future events, it is by means improbable that Socrates admitted, with the generality of his countrymen, the existence of those intermediate beings called *dæmons*, of one of which he might fancy himself the peculiar care.

It was one of the maxims of Socrates, "That a wise man will worship the gods according to the institutions of the state to which he belongs." Convinced of the weakness of the human understanding, and perceiving that the pride of philosophy had led his predecessors into futile speculations on the nature and origin of things, he judged it most consistent with true wisdom to speak with caution and reverence concerning the divine nature.

The wisdom and the virtues of this great man, whilst they procured him many followers, created him also many enemies. The Sophists*, whose knavery and ignorance he took every opportunity of exposing to public contempt, became inveterate in their enmity against so bold a reformer, and devised an expedient, by which they hoped to check the current of his popularity. They engaged Aristophanes, the first buffoon of the age, to write a comedy, in which Socrates should be the principal character. Aristophanes, pleased with so promising an occasion of displaying his low and malignant wit, undertook the task, and produced the comedy of *The Clouds*, still extant in his works. In this piece, Socrates is introduced hanging in a basket in the air, and thence pouring forth absurdity and profaneness. But the philosopher, showing in a crowded theatre that he was wholly unmoved by this ribaldry, the satire failed of its effect; and when Aristophanes attempted the year following to renew the piece with alterations and additions, the representation was so much discouraged, that he was obliged to discontinue it.

* See *Sophist*.

From this time Socrates continued for many years to pursue without interruption his laudable design of instructing and reforming his fellow-citizens. At length, however, when the inflexible integrity with which he had discharged the duty of a senator, and the firmness with which he had opposed every kind of political corruption and oppression, had greatly increased the number of his enemies, clandestine arts were employed to raise a general prejudice against him. The people were industriously reminded, that Critias, who had been one of the most cruel of the thirty tyrants, and Alcibiades,

who

Socrates. who had insulted religion, by defacing the public statues of Mercury, and performing a mock representation of the Eleusinian mysteries, had in their youth been disciples of Socrates; and the minds of the populace being thus prepared, a direct accusation was preferred against him before the supreme court of judicature. His accusers were Anytus a leather-dresser, who had long entertained a personal enmity against Socrates, for reprehending his avarice, in depriving his sons of the benefits of learning, that they might pursue the gains of trade; Melitus, a young rhetorician, who was capable of undertaking any thing for the sake of gain; and Lycon, who was glad of any opportunity of displaying his talents. The accusation, which was delivered to the senate under the name of Melitus, was this: "Melitus, son of Melitus, of the tribe of Pythos, accuseth Socrates, son of Sophroniscus, of the tribe of Alopece. Socrates violates the laws, in not acknowledging the gods which the state acknowledges, and by introducing new divinities. He also violates the laws by corrupting the youth. Be his punishment DEATH."

This charge was delivered upon oath to the senate; and Crito a friend of Socrates became surety for his appearance on the day of trial. Anytus soon afterwards sent a private message to Socrates, assuring him that if he would desist from censuring his conduct, he would withdraw his accusation. But Socrates refused to comply with so degrading a condition; and with his usual spirit replied, "Whilst I live I will never disguise the truth, nor speak otherwise than my duty requires." The interval between the accusation and the trial he spent in philosophical conversations with his friends, choosing to discourse upon any other subject rather than his own situation.

When the day of trial arrived, his accusers appeared in the senate, and attempted to support their charge in three distinct speeches, which strongly marked their respective characters. Plato, who was a young man, and a zealous follower of Socrates, then rose up to address the judges in defence of his master; but whilst he was attempting to apologise for his youth, he was abruptly commanded by the court to sit down. Socrates, however needed no advocate. Ascending the chair with all the serenity of conscious innocence, and with all the dignity of superior merit, he delivered, in a firm and manly tone, an unpremeditated defence of himself, which silenced his opponents, and ought to have convinced his judges. After tracing the progress of the conspiracy which had been raised against him to its true source, the jealousy and resentment of men whose ignorance he had exposed, and whose vices he had ridiculed and reproved, he distinctly replied to the several charges brought against him by Melitus. To prove that he had not been guilty of impiety towards the gods of his country, he appealed to his frequent practice of attending the public religious festivals. The crime of introducing new divinities, with which he was charged, chiefly as it seems on the ground of the admonitions which he professed to have received from an invisible power, he disclaimed, by pleading that it was no new thing for men to consult the gods and receive instructions from them. To refute the charge of his having been a corrupter of youth, he urged the example which he had uniformly exhibited of justice, moderation, and temperance; the moral spirit and tendency of his discourses; and the effect which had actually been produced by his doctrine upon the manners of the young. Then, disdaining to solicit the mercy of his judges, he called upon them for that justice which their office and their oath obliged them to administer; and professing his faith and confidence in God, resigned himself to their pleasure. Socrates.

The judges, whose prejudices would not suffer them to pay due attention to this apology, or to examine with impartiality the merits of the cause, immediately declared him guilty of the crimes of which he stood accused. Socrates, in this stage of the trial, had a right to enter his plea against the punishment which the accusers demanded, and instead of the sentence of death, to propose some pecuniary amercement. But he at first peremptorily refused to make any proposal of this kind, imagining that it might be construed into an acknowledgement of guilt; and asserted, that his conduct merited from the state reward rather than punishment. At length, however, he was prevailed upon by his friends to offer upon their credit a fine of thirty *minæ*. The judges, notwithstanding, still remained inexorable: they proceeded, without farther delay, to pronounce sentence upon him; and he was condemned to be put to death by the poison of hemlock.

The sentence being passed, he was sent to prison: which, says Seneca, he entered with the same resolution and firmness with which he had opposed the thirty tyrants; and took away all ignominy from the place, which could not be a prison while he was there. He lay in fetters 30 days; and was constantly visited by Crito, Plato, and other friends, with whom he passed the time in dispute after his usual manner. Anxious to save so valuable a life, they urged him to attempt his escape, or at least to permit them to convey him away; and Crito went so far, as to assure him that, by his interest with the jailor, it might be easily accomplished, and to offer him a retreat in Thessaly; but Socrates rejected the proposal, as a criminal violation of the laws; and asked them, whether there was any place out of Attica which death could not reach.

At length the day arrived when the officers to whose care he was committed delivered to Socrates early in the morning the final order for his execution, and immediately, according to the law, set him at liberty from his bonds. His friends, who came thus early to the prison that they might have an opportunity of conversing with their master through the day, found his wife sitting by him with a child in her arms. Socrates, that the tranquillity of his last moments might not be disturbed by her unavailing lamentations, requested that she might be conducted home. With the most frantic expressions of grief she left the prison. An interesting conversation then passed between Socrates and his friends, which chiefly turned upon the immortality of the soul. In the course of this conversation, he expressed his disapprobation of the practice of suicide, and assured his friends that his chief support in his present situation was an expectation, though not unmixed with doubts, of a happy existence after death. "It would be inexcusable in me (said he) to despise death, if I were not persuaded that it will conduct me into the presence of the gods, who are the most righteous governors, and into the society of just and good men: but I derive confidence from the hope that something of man remains after death, Socrates.

death, and that the condition of good men will then be much better than that of the bad." Crito afterwards asking him, in what manner he wished to be buried? Socrates replied, with a smile, "As you please, provided I do not escape out of your hands." Then, turning to the rest of his friends, he said, "Is it not strange, after all that I have said to convince you that I am going to the society of the happy, that Crito still thinks that this body, which will soon be a lifeless corpse, is Socrates? Let him dispose of my body as he pleases, but let him not at its interment mourn over it as if it were Socrates."

Towards the close of the day he retired into an adjoining apartment to bathe; his friends, in the mean time, expressing to one another their grief at the prospect of losing so excellent a father, and being left to pass the rest of their days in the solitary state of orphans. After a short interval, during which he gave some necessary instructions to his domestics, and took his last leave of his children, the attendant of the prison informed him, that the time for drinking the poison was come. The executioner, though accustomed to such scenes, shed tears as he presented the fatal cup. Socrates received it without change of countenance or the least appearance of perturbation: then offering up a prayer to the gods that they would grant him a prosperous passage into the invisible world, with perfect composure he swallowed the poisonous draught. His friends around him burst into tears. Socrates alone remained unmoved. He upbraided their pusillanimity, and entreated them to exercise a manly constancy worthy of the friends of virtue. He continued walking till the chilling operation of the hemlock obliged him to lie down upon his bed. After remaining for a short time silent, he requested Crito (probably in order to refute a calumny which might prove injurious to his friends after his decease) not to neglect the offering of a cock which he had vowed to Esculapius. Then, covering himself with his cloak, he expired. Such was the fate of the virtuous Socrates! A story, says Cicero, which I never read without tears.

The friends and disciples of this illustrious teacher of wisdom were deeply afflicted by his death, and attended his funeral with every expression of grief. Apprehensive, however, for their own safety, they soon afterwards privately withdrew from the city, and took up their residence in distant places. Several of them visited the philosopher Euclid of Megara, by whom they were kindly received. No sooner was the unjust condemnation of Socrates known through Greece, than a general indignation was kindled in the minds of good men, who universally regretted that so distinguished an advocate for virtue should have fallen a sacrifice to jealousy and envy. The Athenians themselves, so remarkable for their caprice, who never knew the value of their great men till after their death, soon became sensible of the folly as well as criminality of putting to death the man who had been the chief ornament of their city and of the age, and turned their indignation against his accusers. Melitus was condemned to death; and Anytus, to escape a similar fate, went into voluntary exile. To give a farther proof of the sincerity of their regret, the Athenians for a while interrupted public business; decreed a general mourning; recalled the exiled friends of Socrates; and erected a statue to his memory in one of the most frequented parts of the city. His death happened in the first year of the 96th olympiad, and in the 70th year of his age.

Socrates, Soda.

Socrates left behind him nothing in writing; but his illustrious pupils Xenophon and Plato have in some measure supplied this defect. The Memoirs of Socrates, written by Xenophon, afford, however, a much more accurate idea of the opinions of Socrates, and of his manner of teaching, than the Dialogues of Plato, who everywhere mixes his own conceptions and diction with the ideas and language of his master. It is related, that when Socrates heard Plato recite his Lysis, he said, "How much does this young man make me say which I never conceived!"

His distinguishing character was that of a moral philosopher; and his doctrine concerning God and religion was rather practical than speculative. But he did not neglect to build the structure of religious faith upon the firm foundation of an appeal to natural appearances: He taught, that the Supreme Being, though invisible, is clearly seen in his works: which at once demonstrate his existence and his wise and benevolent providence. He admitted, besides the one Supreme Deity, the existence of beings who possess a middle station between God and man, to whose immediate agency he ascribed the ordinary phenomena of nature, and whom he supposed to be particularly concerned in the management of human affairs. Hence he declared it to be the duty of every one, in the performance of religious rites, to follow the customs of his country. At the same time, he taught, that the merit of all religious offerings depends upon the character of the worshipper, and that the gods take pleasure in the sacrifices of none but the truly pious.

Concerning the human soul, the opinion of Socrates, according to Xenophon, was, that it is allied to the Divine Being, not by a participation of essence, but by a similarity of nature; that man excels all other animals in the faculty of reason; and that the existence of good men will be continued after death in a state in which they will receive the reward of their virtue. Although it appears that on this latter topic he was not wholly free from uncertainty, the consolation which he professed to derive from this source in the immediate prospect of death, leaves little room to doubt that he entertained a real expectation of immortality: and there is reason to believe that he was the only philosopher of ancient Greece whose principles admitted of such an expectation (see METAPHYSICS, Part III Chap. iv.). Of his moral system, which was in a high degree pure, and founded on the surest basis, the reader will find a short view in our article MORAL PHILOSOPHY, N° 4.

SOCRATES was also the name of an ecclesiastical historian of the 5th century, born at Constantinople in the beginning of the reign of Theodosius: he professed the law and pleaded at the bar, whence he obtained the name of *Scholasticus*. He wrote an ecclesiastical history from the year 309, where Eusebius ended, down to 440; and wrote with great exactness and judgement. An edition of Eusebius and Socrates, in Greek and Latin, with notes by Reading, was published at London in 1720.

SODA, the name given by the French chemists to the mineral alkali, which is found native in many parts of the world: it is obtained also from common salt, and from

from the afhes of the *kali*, a fpecies of falfola. See CHEMISTRY *Index*, for an account of its properties and combinations: but long after that article was written, foda and potafh were decompofed by means of galvanifm; and the alkalies, hitherto confidered as fimple fubftances, appear, from the experiments of Mr Davy, who firft made the difcovery, to be compounds of oxygen and a metallic bafe. Mr Davy's conclufions have been controverted by fome of the French chemifts; and as the fubject may perhaps in a few months receive fome farther elucidation, we fhall delay our account of the whole till we come to defcribe the apparatus by which the experiments are conducted. See *TROUGH*, *Galvanic*.

SODA is alfo a name for a heat in the ftomach, or heart-burn. See MEDICINE, N° 275.

SODOM, formerly a town of Paleftine in Afia, famous in Scripture for the wickednefs of its inhabitants, and their deftruction by fire from heaven on account of that wickednefs. The place where it ftood is now covered by the waters of the Dead fea, or the lake Afphaltites. See ASPHALTITES.

SODOMY, an unnatural crime, fo called from the city of Sodom, which was deftroyed by fire for the fame. The Levitical law adjudged thofe guilty of this execrable crime to death; and the civil law affigns the fame punifhment to it. The law of England makes it felony. There is no ftatute in Scotland againft Sodomy; the libel of the crime is therefore founded on the divine law, and practice makes its punifhment to be burned alive.

SODOR, a name always conjoined with Man, in mentioning the bifhop of Man's diocefe. Concerning the origin and application of this word, very different opinions have been formed by the learned. Buchanan (lib. i. cap. 34.) fays, that before his time the name of *Sodor* was given to a town in the ifle of Man. In Gough's edition of Camden's *Britannia* (vol. iii. p. 701.) it is faid, that after the ifle of Man was annexed to the crown of England, this appellation was given to a fmall ifland within mufket-fhot of Man, in which the cathedral ftands, called by the Norwegians the *Holm*, and by the inhabitants the *Peel*. In fupport of this opinion a charter is quoted A. D. 1505, in which Thomas earl of Derby and lord of Man confirms to Huan Hefketh bifhop of Sodor all the lands, &c. anciently belonging to the bifhops of Man. " Ecclefiam cathedralem fancti Germani in *Holm Sodor vel Pele* vocatam, ecclefiam fancti Patricii ibidem, et locum præfatum in quo ecclefiæ præfatæ fitæ funt." The truth of either, or perhaps of both, thefe accounts might be allowed; but neither of them is fufficient to account for the conftant conjunction of Sodor and Man, in charters, regifters, and hiftories. If Sodor was a fmall town or ifland belonging to Man, it cannot be conceived why it is always mentioned before it, or rather why it fhould be mentioned at all in fpeaking of a bifhop's diocefe. To fpeak of the bifhopric of Sodor and Man in this cafe would be as improper as it would be to call the bifhopric of Durham the bifhopric of Holy Ifland and Durham, or the bifhopric of Darlington and Durham; the former being a fmall ifland and the latter a town belonging to the county and diocefe of Durham. Neither of thefe accounts, therefore, gives a fatisfactory account of the original conjunction of Sodor and Man.

The ifland of Iona was the place where the bifhop of the Ifles refided, the cathedral church of which, it is faid, was dedicated to our Saviour, in Greek *Soter*, hence *Sotorenfes*, which might be corrupted into *Sodorenfes*, a name frequently given by Danifh writers to the weftern ifles of Scotland. That we may be the more difpofed to accede to this Grecian etymology, the advocates for this opinion tell us, that the name *Icolumkill*, which is often applied to this ifland, is alfo of Greek extraction, being derived from *Columba*, " a pigeon;" a meaning that exactly correfponds to the Celtic word *Colum* and the Hebrew word *Iona*. We muft confefs, however, that we have very little faith in the conjectures of etymologifts, and think that upon no occafion they alone can eftablifh any fact, though when concurring with facts they certainly tend to confirm and explain them. It is only from hiftorical facts that we can know to what Sodor was applied.

It appears from the hiftory of the Orkneys, compiled by an old Icelandic writer, tranflated and enlarged by Torfæus, that the Æbudæ or Weftern ifles of Scotland were divided into two clufters, Nordureys and Sudereys. The Nordureys, which were feparated from the Sudereys by the point of Ardnamurchan, a promontory in Argylefhire, confifted of Muck, Egg, Rum, Canna, Skye, Rafay, Barra, South Uift, North Uift, Benbecula, and Lewis, including Harris, with a great number of fmall ifles. The Sudereys were, Man, Arran, Bute, Cumra, Avon, Gid, Ila, Colonfay, Jura, Scarba, Mull, Iona, Tiree, Coll, Ulva, and other fmall iflands. All thefe, when joined together, and fubject to the fame prince, made up the kingdom of Man and the Ifles. In the Norwegian language, *Suder* and *Norder* fignify fouthern and northern, and *ey* or *ay* an ifland. When the Æbudæ were under one monarch, the feat of empire was fixed in the Sudereys, and the Nordureys were governed by deputies; hence the former are much oftener mentioned in hiftory than the latter; hence, too, the Sudereys often comprehend the Nordureys, as in our days Scotland is fometimes comprehended under England. Sudereys, or Suder, when anglicifed, became Sodor; and all the Weftern ifles of Scotland being included in one diocefe under the Norwegian princes, the bifhop appointed to fuperintend them was called the bifhop of Man and the Ifles, or the bifhop of Sodor and Man. Since Man was conquered by Edward III. it has been feparated from the other ifles, and its bifhops have exercifed no jurifdiction over them. Should it now be afked, why then is the bifhop of Man ftill called the bifhop of Sodor and Man? we reply, that we have been able to difcover no reafon; but fuppofe the appellation to be continued in the fame way, as the title king of France has been kept up by the kings of Great Britain, for feveral centuries after the Englifh were entirely expelled from France.

SOFA, in the eaft, a kind of alcove raifed half a foot above the floor of a chamber or other apartment; and ufed as the place of ftate, where vifitors of diftinction are received. Among the Turks the whole floor of their ftate-rooms is covered with a kind of tapeftry, and on the window-fide is raifed a fofa or fopha, laid with a kind of mattrefs, covered with a carpet much richer than the other. On this carpet the Turks are feated, both men and women, like the tailors in England, crofs-legged, leaning againft the wall, which is bolstered with velvet, satin, or other stuff suitable to the season. Here they eat their meals; only laying a skin over the carpet to serve as a tablecloth, and a round wooden board over all, covered with plates, &c.

SOFALA, or Cefala, a kingdom of Africa, lying on the coast of Mosambique, near Zanguebar. It is bounded on the north by Monomotapa; on the east by the Mosambique sea; on the south by the kingdom of Sabia; and on the west by that of Manica. It contains mines of gold and iron, and a great number of elephants. It is governed by a king, tributary to the Portuguese, who built a fort at the principal town, which is of the same name, and of great importance for their trade to the East Indies. It is seated in a small island, near the mouth of a river. E. Long. 35. 40. S. Lat. 20. 20.

SOFFITA, or Soffit, in *Architecture*, any timber ceiling formed of cross beams of flying corniches, the square compartiments or pannels of which are enriched with sculpture, painting, or gilding; such are those in the palaces of Italy, and in the apartments of Luxembourg at Paris.

Soffita, or *Soffit*, is also used for the underside or face of an architrave; and more particularly for that of the corona or larmier, which the ancients called *lacunar*, the French *plafond*, and we usually the *drip*. It is enriched with compartments of roses; and in the Doric order has 18 drops, disposed in three ranks, six in each, placed to the right of the guttæ, at the bottom of the triglyphs.

SOFI, or Sophi. See Sophi.

SOFTENING, in *Painting*, the mixing and diluting of colours with the brush or pencil.

SOHO, the name of a set of works, or manufactory of a variety of hardwares, belonging to the late Mr Boulton, situated on the borders of Staffordshire, within two miles of Birmingham; now so justly celebrated as to deserve a short historical detail.

About 30 years ago the premises consisted of a small mill and a few obscure dwellings. Mr Boulton, in conjunction with Mr Fothergill, then his partner, at an expence of 9000l. erected a handsome and extensive edifice, with a view of manufacturing metallic toys. The first productions consisted of buttons, buckles, watch-chains, trinkets, and such other articles as were peculiar to Birmingham. Novelty, taste, and variety, were however always conspicuous; and plated wares, known by the name of Sheffield plate, comprising a great variety of useful and ornamental articles, became another permanent subject of manufacture.

To open channels for the consumption of these commodities, all the northern part of Europe was explored by the mercantile partner Mr Fothergill. A wide and extensive correspondence was thus established, the undertaking became well known, and the manufacturer, by becoming his own merchant, eventually enjoyed a double profit.

Impelled by an ardent attachment to the arts, and by the patriotic ambition of forming his favourite Soho into a fruitful seminary of artists, the proprietor extended his views; and men of taste and talents were now sought for, and liberally patronised. A successful imitation of the French *or moulise* ornaments, consisting of vases, tripods, candelabra, &c. &c. extended the celebrity of the works. Services of plate and other works in silver, both massive and airy, were added, and an assay office was established in Birmingham.

Mr Watt, the ingenious improver of the steam-engine, was afterwards taken into partnership with Mr Boulton; and they carried on at Soho a manufactory of steam-engines, not less beneficial to the public than lucrative to themselves. This valuable machine, the nature and excellencies of which are described in another place (see *STEAM-Engine*), Mr Boulton proposed to apply to the operation of coining, and suitable apparatus was erected at a great expence, for the purpose of being employed by government to make a new copper-coinage for the kingdom. Artists of merit were engaged, and specimens of exquisite delicacy were exhibited; the works were also employed upon highly finished medals and private coins. To enumerate all the productions of this manufactory would be tedious (A).

In a national view, Mr Boulton's undertakings are highly valuable and important. By collecting around him artists of various descriptions, rival talents have been called forth, and by successive competition have been multiplied to an extent highly beneficial to the public. The manual arts partook of the benefit, and became proportionably improved.

A barren heath has been covered with plenty and population; and Mr Boulton's works, which in their infancy were little known and attended to, now cover several acres, give employment to more than 600 persons, and are said to be the first of their kind in Europe.

SOIL, the mould covering the surface of the earth, in which vegetables grow. It serves as a support for vegetables, and as a reservoir for receiving and communicating their nourishment.

Soils are commonly double or triple compounds of the several reputed primitive earths, except the barytic. The magnesian likewise sparingly occurs. The more fertile soils afford also a small proportion of coally substance arising from putrefaction, and some traces of marine acid and gypsum. The vulgar division into clay, chalk, sand, and gravel, is well understood. Loam denotes any soil moderately adhesive; and, according to the ingredient that predominates, it receives the epithets of clayey, chalky, sandy, or gravelly. The intimate mixture of clay with the oxydes of iron is called *till*, and is of a hard consistence and a dark reddish colour. Soils are found by analysis to contain their earthy ingredients in very different proportions. According to M. Giobert, fertile mould in the vicinity of Turin, where the fall of rain amounts yearly to 40 inches, affords for each 100 parts, from 77 to 79 of silex, from 8 to 14 of argill, and from 5 to 12 of calx; besides about one-half of carbonic matter, and nearly an equal weight of gas, partly carbonic and partly hydrocarbonic. The same experimenter represents the composition of barren soils in similar situations to be from 42 to 88 per cent. of silex,

(A) It was at this place, in the year 1772, that Mr Eginton invented an expeditious method of copying pictures in oil; but we do not know how far this method has succeeded.

lex, from 20 to 30 of argill, and from 4 to 20 of calx. The celebrated Bergman found rich soils in the valleys of Sweden, where the annual quantity of rain is 24 inches, to contain, for each 100 parts, 56 of filiceous fand, 14 of argill, and 30 of calx. In the climate of Paris, where the average fall of rain is 20 inches, fertile mixtures, according to M. Tillet, vary from 46 to 52 per cent. of filex, and from 11 to 17 of argill, with 37 of calx. Hence it appears that in dry countries rich earths are of a clofer texture, and contain more of the calcareous ingredient, with lefs of the filiceous. Mr Arthur Young has difcovered, that the value of fertile lands is nearly proportioned to the quantities of gas which equal weights of their foil afford by diftillation. See AGRICULTURE *Index*.

SOISSONS, an ancient, large, and confiderable city of France, in the department of Aifne and late province of Soiffonnois. It was the capital of a kingdom of the fame name, under the firft race of the French monarchs. It contains about 12,000 inhabitants, and is a bifhop's fee. The environs are charming, but the ftreets are narrow, and the houfes ill-built. The fine cathedral has one of the moft confiderable chapters in the kingdom; and the bifhop, when the archbifhop of Rheims was abfent, had a right to crown the king. The caftle, though ancient, is not that in which the kings of the firft race refided. Soiffons is feated in a very pleafant and fertile valley, on the river Aifne, 30 miles weft by north of Rheims, and 60 north-eaft of Paris. E. Long. 3. 24. N. Lat. 49. 23.

SOKE, or SOK. See SOCAGE.

SOKEMANS. See SOC and SOCAGE.

SOL, in *Mufic*, the fifth note of the gamut, *ut*, *re*, *mi*, *fa*, *fol*, *la*. See GAMUT.

SOL, or *Sou*, a French coin made up of copper mixed with a little filver, and is worth upwards of an Englifh halfpenny, or the 23d part of an Englifh fhilling. The fol when firft ftruck was equal in value to 12 deniers Tournois, whence it was alfo called *douzain*, a name it ftill retains, though its ancient value be changed; the fol having been fince augmented by three deniers, and ftruck with a puncheon of a fleur-de-lis, to make it current for 15 deniers. Soon after the old fols were coined over again, and both old and new were indifferently made current for 15 deniers. In 1709, the value of the fame fols was raifed to 18 deniers. Towards the latter end of the reign of Louis XIV. the fol of 18 deniers was again lowered to 15; and by the late king it was reduced to the original value of 12. What it is at prefent pofterity may perhaps difcover.

The Dutch have alfo two kinds of fols: the one of filver, called *fols de gros*, and likewife *fchelling*; the other of copper, called alfo the *fluyver*.

SOL, the *Sun*, in *Aftronomy*, *Aftrology*, &c. See ASTRONOMY, *paffim*.

SOL, in *Chemiftry*, is gold; thus called from an opinion that this metal is in a particular manner under the influence of the fun.

SOL, in *Heraldry*, denotes Or, the golden colour in the arms of fovereign princes.

SOLÆUS, or SOLEUS, in *Anatomy*, one of the extenfor mufcles of the foot, rifing from the upper and hinder parts of the tibia and fibula.

SOLAN-GOOSE. See PELICANUS, ORNITHOLOGY *Index*.

SOLANDRA, a genus of plants belonging to the clafs of monadelphia, and to the order of polyandria; and in the natural fyftem arranged under the 38th order, *Tricoccæ*. See BOTANY *Index*.

SOLANUM, a genus of the monogynia order, belonging to the pentandria clafs of plants; and in the natural method ranking under the 28th order, *Luridæ*. See BOTANY *Index*.

SOLAR, fomething belonging to the SUN.

SOLAR-Spots. See ASTRONOMY *Index*.

SOLDAN. See SULTAN.

SOLDANELLA, a genus of plants belonging to the clafs of pentandria, and order of monogynia; and in the natural fyftem arranged under the 21ft order, *Preciæ*. See BOTANY *Index*.

SOLDER, SODDER, or *Soder*, a metallic or mineral compofition ufed in foldering or joining together other metals.

Solders are made of gold, filver, copper, tin, bifmuth, and lead; ufually obferving, that in the compofition there be fome of the metal that is to be foldered mixed with fome higher and finer metals. Goldfmiths ufually make four kinds of folder, viz. folder of eight, where to feven parts of filver there is one of brafs or copper; folder of fix, where only a fixth part is copper; folder of four, and folder of three. It is the mixture of copper in the folder that makes raifed plate come always cheaper than flat.

As mixtures of gold with a little copper are found to melt with lefs heat than pure gold itfelf, thefe mixtures ferve as folders for gold: two pieces of fine gold are foldered by gold that has a fmall admixture of copper; and gold alloyed with copper is foldered by fuch as is alloyed with more copper: the workmen add a little filver as well as copper, and vary the proportions of the two to one another, fo as to make the colour of the folder correfpond as nearly as may be to that of the piece. A mixture of gold and copper is alfo a folder for fine copper as well as for fine gold. Gold being particularly difpofed to unite with iron, proves an excellent folder for the finer kinds of iron and fteel inftruments.

The folder ufed by plumbers is made of two pounds of lead to one of block-tin. Its goodnefs is tried by melting it, and pouring the bignefs of a crown-piece on a table; for, if good, there will arife little bright fhining ftars therein. The folder for *copper* is made like that of the plumbers; only with copper and tin; and for very nice works, inftead of tin, they fometimes ufe a quantity of filver. Solder for *tin* is made of two-thirds of tin and one of lead, or of equal parts of each; but where the work is any thing delicate, as in organ-pipes, where the juncture is fcarce difcernible, it is made of one part of bifmuth and three parts of pewter. The pewterers ufe a kind of folder made with two parts of tin and one of bifmuth; this compofition melts with the leaft heat of any of the folders.

Silver folder is that which is made of two parts of filver and one of brafs, and ufed in foldering thofe metals. Spelter folder is made of one part of brafs and two of fpelter or zinc, and is ufed by the braziers and copperfmiths for foldering brafs, copper, and iron. This folder is improved by adding to each ounce of it one pennyweight of filver; but as it does not melt without a confiderable degree of heat, it cannot be ufed when it it is inconvenient to heat the work red-hot; in which case copper and brass are soldered with silver.

Though spelter solder be much cheaper than silver-solder, yet workmen in many cases prefer the latter. And Mr Boyle informs us, that he has found it to run with so moderate a heat, as not much to endanger the melting of the delicate parts of the work to be soldered; and if well made, this silver solder will lie even upon the ordinary kind itself; and so fill up those little cavities that may chance to be left in the first operation, which is not easily done without a solder more easily fusible than the first made use of. As to iron, it is sufficient that it be heated to a white heat, and the two extremities, in this state, be hammered together; by which means they become incorporated one with the other.

SOLDERING, the joining and fastening together of two pieces of the same metal, or of two different metals, by the fusion and application of some metallic composition on the extremities of the metals to be joined.

To solder upon silver, brass, or iron: Take silver, five pennyweights; brass, four pennyweights: melt them together for soft solder, which runs soonest. Take silver, five pennyweights; copper, three pennyweights: melt them together for hard solder. Beat the solder thin, and lay it on the place to be soldered, which must be first fitted and bound together with wire as occasion requires; then take borax in powder, and temper it like pap, and lay it upon the solder, letting it dry; then cover it with live coals, and blow, and it will run immediately; take it presently out of the fire, and it is done. It is to be observed, that if any thing is to be soldered in two places, which cannot well be done at one time, you must first solder with the harder solder, and then with the soft; for if it be first done with the soft, it will unsolder again before the other is fastened. Let it be observed, that if you would not have your solder run about the piece that is to be soldered, you must rub such places over with chalk.—In the soldering either of gold, silver, copper, or either of the metals above mentioned, there is generally used borax in powder, and sometimes rosin. As to iron, it is sufficient that it be heated red-hot, and the two extremities thus hammered together, by which means they will become incorporated with each other. For the finer kinds of iron and steel instruments, however, gold proves an excellent solder. This metal will dissolve twice or thrice its weight of iron in a degree of heat very far less than that in which iron itself melts; hence if a small plate of gold is wrapped round the parts to be joined, and afterwards melted by a blow-pipe, it strongly unites the pieces together without any injury to the instrument, however delicate.

SOLDIER, a military man listed to serve a prince or state in consideration of a certain daily pay.

SOLDIER-Crab. See CANCER, ENTOMOLOGY *Index*.

Fresh Water SOLDIER. See STRATIOTES, BOTANY *Index*.

SOLE, in the manege, a sort of horn under a horse's foot, which is much more tender than the other horn that encompasses the foot, and by reason of its hardness is properly called the *horn* or *hoof*.

SOLE. See PLEURONECTES, ICHTHYOLOGY *Index*.

SOLEA. See SANDAL and SHOE.

SOLECISM, in *Grammar*, a false manner of speaking, contrary to the rules of grammar, either in respect of declension, conjugation, or syntax.—The word is Greek, σολοικισμος, derived from the *Soli*, a people of Attica, who being transplanted to Cilicia, lost the purity of their ancient tongue, and became ridiculous to the Athenians for the improprieties into which they fell.

SOLEMN, something performed with much pomp, ceremony, and expence. Thus we say, solemn feasts, solemn funerals, solemn games, &c.—In law, *solemn* signifies something authentic, or what is clothed in all its formalities.

SOLEN, RAZOR-SHEATH, or *Knife-handle Shell;* a genus belonging to the class of *vermes*, and order of *testacea*. See CONCHOLOGY *Index*.

SOLEURE, a canton of Swisserland, which holds the 11th rank in the Helvetic confederacy, into which it was admitted in the year 1481. It stretches partly through the plain, and partly along the chains of the Jura, and contains about 50,000 inhabitants. It is 35 miles in length from north to south, and 35 in breadth from east to west. The soil for the most part is exceedingly fertile in corn; and the districts within the Jura abound in excellent pastures. The trade both of the town and canton is of little value, although they are very commodiously situated for an extensive commerce. It is divided into 11 bailiwicks, the inhabitants of which are all Roman Catholics except those of the bailiwick of Buckegberg, who profess the reformed religion. The sovereign power resides in the great council, which, comprising the senate or little council of 36, consists of 102 members, chosen by the senate in equal proportions from the 11 tribes or companies into which the ancient burghers are distributed; and, owing to the distinction between the ancient and the new burghers (the former consisting of only 85 families) the government was formerly a complete aristocracy.

SOLEURE, an ancient and extremely neat town of Swisserland, capital of the canton of the same name. It contains about 4000 inhabitants, and is pleasantly seated on the Aar, which here expands into a noble river. Among the most remarkable objects of curiosity in this town is the new church of St Urs, which was begun in 1762 and finished in 1772. It is a noble edifice of a whitish grey stone, drawn from the neighbouring quarries, which admits a polish, and is a species of rude marble. The lower part of the building is of the Corinthian, the upper of the Composite order. The façade, which consists of a portico, surmounted by an elegant tower, presents itself finely at the extremity of the principal street. It cost at least 80,000l. a considerable sum for such a small republic, whose revenue scarcely exceeds 12,000l. a-year. Soleure is surrounded by regular stone fortifications, and is 20 miles north-north-east of Bern, 27 south-south-west of Basle, and 45 west of Zurich. E. Long. 7. 20. N. Lat. 47. 15.

SOLFAING, in *Music*, the naming or pronouncing the several notes of a song by the syllables *ut*, *re*, *mi*, *fa*, *sol*, &c. in learning to sing it.

Of the seven notes in the French scale *ut*, *re*, *mi*, *fa*, *sol*, *la*, *si*, only four are used among us in singing, as *mi*, *fa*, *sol*, *la*: their office is principally, in singing, that by applying them to every note of the scale, it may not only be pronounced with more ease, but chiefly that by them the tones and semitones of the natural scale may be better marked out and distinguished. This design is obtained by the four syllables *fa*, *sol*, *la*, *mi*.

Thus from *fa* to *sol* is a tone, also from *sol* to *la*, and from *la* to *mi*, without distinguishing the greater or less tone; but from *la* to *fa*, also from *mi* to *fa*, is only a semitone. If then these be applied in this order, *fa*, *sol*, *la*, *fa*, *sol*, *la*, *mi*, *fa*, &c. they express the natural series from C; and if that be repeated to a second or third octave, we see by them how to express all the different orders of tones and semitones in the diatonic scale; and still above *mi* will stand, *fa*, *sol*, *la*, and below it the same inverted *la*, *sol*, *fa*, and one *mi* is always distant from another an octave; which cannot be said of any of the rest, because after *mi* ascending come always *fa*, *sol*, *la*, which are repeated invertedly descending.

To conceive the use of this, it is to be remembered, that the first thing in learning to sing, is to make one raise a scale of notes by tones and semitones to an octave, and descend again by the same; and then to rise and fall by greater intervals at a leap, as thirds and fourths, &c. and to do all this by beginning at notes of different pitch. Then those notes are represented by lines and spaces, to which these syllables are applied, and the learners taught to name each line and space thereby, which makes what we call *solfaing*; the use whereof is, that while they are learning to tune the degrees and intervals of sound expressed by notes on a line or space, or learning a song to which no words are applied, they may not only do it the better by means of articulate sounds, but chiefly that by knowing the degrees and intervals expressed by those syllables, they may more readily know the places of the semitones, and the true distance of the notes. See the article SINGING.

SOLFATERRA, a mountain of Italy in the kingdom of Naples, and Terra di Lavoro. This mountain appears evidently to have been a volcano in ancient times; and the soil is yet so hot, that the workmen employed there in making alum need nothing else besides the heat of the ground for evaporating their liquids. Of this mountain we have the following account by Sir William Hamilton. "Near Astruni (another mountain, formerly a volcano likewise) rises the Solfaterra, which not only retains its cone and crater, but much of its former heat. In the plain within the crater, smoke issues from many parts, as also from its sides: here, by means of stones and tiles heaped over the crevices, through which the smoke passes, they collect in an aukward manner what they call *sale armoniaco*; and from the sand of the plain they extract sulphur and alum. This spot, well attended to, might certainly produce a good revenue, whereas I doubt if they have hitherto ever cleared 200l. a-year by it. The hollow sound produced by throwing a heavy stone on the plain of the crater of the Solfaterra, seems to indicate that it is supported by a sort of arched natural vault; and one is induced to think that there is a pool of water beneath this vault (which boils by the heat of a subterraneous fire still deeper), by the very moist steam that issues from the cracks in the plain of the Solfaterra, which, like that of boiling water, runs off a sword or knife, presented to it, in great drops. On the outside, and at the foot of the cone of the Solfaterra, towards the lake of Agnano, water rushes out of the rocks so hot as to raise the quicksilver in Fahrenheit's thermometer to the degree of boiling water (A); a fact of which I was myself an eye-witness. This place, well worthy the observation of the curious, has been taken little notice of; it is called the *Pisciarelli*. The common people of Naples have great faith in the efficacy of this water; and make much of it in all cutaneous disorders, as well as for another disorder that prevails here. It seems to be impregnated chiefly with sulphur and alum. When you approach your ear to the rocks of the Pisciarelli, from whence this water ouzes, you hear a horrid boiling noise, which seems to proceed from the huge cauldron that may be supposed to be under the plain of the Solfaterra. On the other side of the Solfaterra, next the sea, there is a rock which has communicated with the sea, till part of it was cut away to make the road to Puzzole; this was undoubtedly a considerable lava, that ran from the Solfaterra when it was an active volcano. Under this rock of lava, which is more than 70 feet high, there is a stratum of pumice and ashes. This ancient lava is about a quarter of a mile broad; you meet with it abruptly before you come in sight of Puzzole, and it finishes as abruptly within about 100 paces of the town. The ancient name of the Solfaterra was *Forum Vulcani*; a strong proof of its origin from subterraneous fire. The degree of heat that the Solfaterra has preserved for so many ages, seems to have calcined the stones upon its cone and in its crater, as they are very white and crumble easily in the hottest parts.

SOLICITOR, a person employed to take care of and manage suits depending in the courts of law or equity. Solicitors are within the statute to be sworn, and admitted by the judges, before they are allowed to practise in our courts, in like manner as attorneys.

There is also a great officer of the law, next to the attorney-general, who is styled the king's solicitor-general; who holds his office by patent during the king's pleasure, has the care and concern of managing the king's affairs, and has fees for pleading, besides other fees arising by patents, &c. He attends on the privy-council; and the attorney-general and he were anciently reckoned among the officers of the exchequer; they have their audience, and come within the bar in all other courts.

SOLID, in *Philosophy*, a body whose parts are so firmly connected together, as not easily to give way or slip from each other; in which sense *solid* stands opposed to *fluid*.

Geometricians define a solid to be the third species of magnitude, or that which has three dimensions, viz. length, breadth, and thickness or depth.

Solids are commonly divided into regular and irregular. The regular solids are those terminated by regular and

(A) "I have remarked, that after a great fall of rain, the degree of heat in this water is much less; which will account for what Padre Torre says (in his book, intitled *Histoire et Phenomenes du Vesuve*), that when he tried it in company with Monsieur de la Condamine, the degree of heat, upon Reaumur's thermometer, was 68°.

and equal planes, and are only five in number, viz. the tetrahedron, which consists of four equal triangles; the cube or hexahedron, of six equal squares; the octahedron, of eight equal triangles; the dodecahedron, of twelve; and the icosihedron, of twenty equal triangles.

The irregular solids are almost infinite, comprehending all such as do not come under the definition of regular solids; as the sphere, cylinder, cone, parallelogram, prism, parallelopiped, &c.

SOLIDS, in *Anatomy*, are the bones, ligaments, membranes, muscles, nerves and vessels, &c.

The solid parts of the body, though equally composed of vessels, are different with regard to their consistence; some being hard and others soft. The hard, as the bones and cartilages, give firmness and attitude to the body, and sustain the other parts: the soft parts, either alone or together with the hard, serve to execute the animal functions. See ANATOMY.

SOLIDAGO, a genus of plants belonging to the class of *syngenesia*, and to the order of *polygamia superflua*; and in the natural system ranging under the 49th order, *Compositæ*. See BOTANY *Index*.

SOLIDITY, that property of matter, or body, by which it excludes all other bodies from the place which itself possesses; and as it would be absurd to suppose that two bodies could possess one and the same place at the same time, it follows, that the softest bodies are equally solid with the hardest. See METAPHYSICS, N° 44. 173, &c.

Among geometricians, the solidity of a body denotes the quantity or space contained in it, and is called also its solid content.

The solidity of a cube, prism, cylinder, or parallelopiped, is had by multiplying its basis into its height. The solidity of a pyramid or cone is had by multiplying either the whole base into a third part of the height, or the whole height into a third part of the base.

SOLILOQUY, a reasoning or discourse which a man holds with himself; or, more properly, according to Papias, it is a discourse by way of answer to a question that a man proposes to himself.

Soliloquies are become very common on the modern stage; yet nothing can be more inartificial, or more unnatural, than an actor's making long speeches to himself, to convey his intentions to the audience. Where such discoveries are necessary to be made, the poets should rather take care to give the dramatic persons such confidants as may necessarily share their inmost thoughts; by which means they will be more naturally conveyed to the audience; yet even this is a shift which an accurate poet would not have occasion for. The following lines of the duke of Buckingham concerning the use and abuse of soliloquies deserve attention:

> Soliloquies had need be very few,
> Extremely short, and spoke in passion too.
> Our lovers talking to themselves, for want
> Of others, make the pit their confidant:
> Nor is the matter mended yet, if thus
> They trust a friend, only to tell it us.

SOLIMAN II. emperor of the Turks, surnamed the *Magnificent*, was the only son of Selim I. whom he succeeded in 1520. He was educated in a manner very different from the Ottoman princes in general; for he was instructed in the maxims of politics and the secrets of government. He began his reign by restoring those persons their possessions whom his father had unjustly plundered. He re-established the authority of the tribunals, which was almost annihilated, and bestowed the government of provinces upon none but persons of wealth and probity: "I would have my viceroys (he used to say) resemble those rivers that fertilize the fields through which they pass, not those torrents which sweep every thing before them."

After concluding a truce with Ismael Sophy of Persia, and subduing Gozeli Bey, who had raised a rebellion in Syria, he turned his arms against Europe. Belgrade was taken in 1521, and Rhodes fell into his hands the year following, after an obstinate and enthusiastic defence. In 1526 he defeated and slew the king of Hungary in the famous battle of Mohatz. Three years after he conquered Buda, and immediately laid siege to Vienna itself. But after continuing 20 days before that city, and assaulting it 20 times, he was obliged to retreat with the loss of 80,000 men. Some time after he was defeated by the Persians, and disappointed in his hopes of taking Malta. He succeeded, however, in dispossessing the Genoese of Chio, an island which had belonged to that republic for more than 200 years.

He died at the age of 76, while he was besieging Sigeth, a town in Hungary, on the 30th August 1566.

He was a prince of the strictest probity, a lover of justice, and vigorous in the execution of it; but he tarnished all his glory by the cruelty of his disposition. After the battle of Mohatz he ordered 1500 prisoners, most of them gentlemen, to be ranged in a circle, and beheaded in presence of his whole army.

Soliman thought nothing impossible which he commanded: A general having received orders to throw a bridge over the Drave, wrote him, that it was impossible. The sultan sent him a long band of linen with these words written on it: "The emperor Soliman, thy master, orders thee to build a bridge over the Drave in spite of the difficulties thou mayest meet with. He informs thee at the same time, that if the bridge be not finished upon his arrival, he will hang thee with the very linen which informs thee of his will."

SOLIPUGA, or SOLIFUGA, in *Natural History*, the name given by the Romans to a small venomous insect of the spider-kind, called by the Greeks *heliocentros*; both words signifying an animal which stings most in the country and seasons where the sun is most hot. Solinus makes this creature peculiar to Sardinia; but this is contrary to all the accounts given us by the ancients. It is common in Africa and some parts of Europe. Almost all the hot countries produce this venomous little creature. It lies under the sand to seize other insects as they go by; and if it meet with any uncovered part of a man, produces a wound which proves very painful; it is said that the bite is absolutely mortal, but probably this is not true. Solinus writes the word *solifuga*, and so do many others, erroneously deriving the name from the notion that this animal flies from the sun's rays, and buries itself in the sand.

SOLIS, ANTONIO DE, an ingenious Spanish writer, of an ancient and illustrious family, born at Placenza an Old Castile, in 1610. He was intended for the law; but his inclination toward poetry prevailed, and he cultivated it with great success. Philip IV. of Spain made him one of his secretaries; and after his death the queen-regent appointed him historiographer of the Indies, a place of great profit and honour: his History of the Conquest of Mexico shows that she could not have named a fitter person. He is better known by this history at least abroad, than by his poetry and dramatic writings, though in these he was also distinguished. He turned priest at 57 years of age, and died in 1686.

SOLITARY, that which is remote from the company or commerce of others of the same species.

SOLITARIES, a denomination of nuns of St Peter of Alcantara, instituted in 1676, the design of which was to imitate the severe penitent life of that saint. Thus they are to keep a continual silence, never to open their mouths to a stranger; to employ their time wholly in spiritual exercises, and leave their temporal concerns to a number of maids, who have a particular superior in a separate part of the monastery: they always go bare-footed, without sandals; gird themselves with a thick cord, and wear no linen.

SOLO, in the Italian music, is frequently used in pieces consisting of several parts, to mark those that are to perform alone; as *flauto solo*, *violino solo*. It is also used for sonatas composed for one violin, one German flute, or other instrument, and a bass; thus we say, *Corelli's solos*, *Geminiani's solos*, &c. When two or three parts play or sing separately from the grand chorus, they are called a *doi soli*, a *tre soli*, &c. Solo is sometimes denoted by *S*.

SOLOMON, the son of David king of Israel, renowned in Scripture for his wisdom, riches, and magnificent temple and other buildings. Towards the end of his life he sullied all his former glory by his apostacy from God; from which cause vengeance was denounced against his house and nation. He died about 975 B. C.

SOLOMON's Seal, a species of CONVALLARIA, which see, BOTANY *Index*.

SOLON, one of the seven wise men of Greece, was born at Salamis, of Athenian parents, who were descended from Codrus. His father leaving little patrimony, he had recourse to merchandise for his subsistence. He had, however, a greater thirst after knowledge and fame than after riches, and made his mercantile voyages subservient to the increase of his intellectual treasures. He very early cultivated the art of poetry, and applied himself to the study of moral and civil wisdom. When the Athenians, tired out with a long and troublesome war with the Megarensians, for the recovery of the isle of Salamis, prohibited any one, under pain of death, to propose the renewal of their claim to that island, Solon thinking the prohibition dishonourable to the state, and finding many of the younger citizens desirous to revive the war, feigned himself mad, and took care to have the report of his insanity spread through the city. In the mean time he composed an elegy adapted to the state of public affairs, which he committed to memory. Every thing being thus prepared, he sallied forth into the market-place with the kind of cap on his head which was commonly worn by sick persons, and, ascending the herald's stand, he delivered, to a numerous crowd, his lamentation for the desertion of Salamis. The verses were heard with general applause; and Pisistratus seconded his advice, and urged the people to renew the war. The decree was immediately repealed; the claim to Salamis was resumed; and the conduct of the war was committed to Solon and Pisistratus, who, by means of a stratagem, defeated the Megarensians, and recovered Salamis.

His popularity was extended through Greece in consequence of a successful alliance which he formed among the states in defence of the temple at Delphos against the Cirrhæans. When dissensions had arisen at Athens between the rich creditors and their poor debtors, Solon was created archon, with the united powers of supreme legislator and magistrate. He soon restored harmony between the rich and poor: He cancelled the debts which had proved the occasion of so much oppression; and ordained that in future no creditor should be allowed to seize the body of the debtor for his security: He made a new distribution of the people, instituted new courts of judicature, and framed a judicious code of laws, which afterwards became the basis of the laws of the twelve tables in Rome. Among his criminal laws are many wise and excellent regulations; but the code is necessarily defective with respect to those principles which must be derived from the knowledge of the true God, and of pure morality, as the certain foundations of national happiness. Two of them in particular were very exceptionable; the permission of a voluntary exile to persons that had been guilty of premeditated murder, and the appointment of a less severe punishment for a rape than for seduction. Those who wish to see accurately stated the comparative excellence of the laws of Moses, of Lycurgus, and Solon, may consult Prize Dissertations relative to Natural and Revealed Religion by Teyler's Theological Society, vol. ix.

The interview which Solon is said to have had with Crœsus king of Lydia, the solid remarks of the sage after surveying the monarch's wealth, the recollection of those remarks by Crœsus when doomed to die, and the noble conduct of Cyrus on that occasion, are known to every schoolboy. Solon died in the island of Cyprus, about the 80th year of his age. Statues were erected to his memory both at Athens and Salamis. His thirst after knowledge continued to the last: "I grow old (said he) learning many things." Among the apophthegms and precepts which have been ascribed to Solon, are the following: Laws are like cobwebs, that entangle the weak, but are broken through by the strong. He who has learned to obey, will know how to command. In all things let reason be your guide. Diligently contemplate excellent things. In every thing that you do, consider the end.

SOLSTICE, in *Astronomy*, that time when the sun is in one of the solstitial points; that is, when he is at his greatest distance from the equator; thus called because he then appears to stand still, and not to change his distance from the equator for some time; an appearance owing to the obliquity of our sphere, and which those living under the equator are strangers to.

The solstices are two in each year; the æstival or summer solstice, and the hyemal or winter solstice. The summer solstice is when the sun seems to describe the tropic of cancer, which is on June 22. when he makes the longest day: the winter solstice is when the sun enters the first degree, or seems to describe the tropic of capricorn, which is on December 22. when he makes the shortest day. This is to be understood as in our northern hemisphere; for in the southern, the sun's entrance

trance into capricorn makes the summer solstice, and that into cancer the winter solstice. The two points of the ecliptic, wherein the sun's greatest ascent above the equator, and his descent below it, are terminated, are called the *solstitial points*; and a circle, supposed to pass through the poles of the world and these points, is called the *solstitial colure*. The summer solstitial point is in the beginning of the first degree of cancer; and is called the *æstival* or *summer point*; and the winter solstitial point is in the beginning of the first degree of capricorn, and is called the *winter point*. These two points are diametrically opposite to each other.

SOLUTION, in *Chemistry*, denotes an intimate union of solid with fluid bodies, so as to form a transparent liquor. See CHEMISTRY *passim*.

SOLVENT, that which dissolves a solid body into a transparent fluid.

SOLWAY MOSS. See *Moving Moss*.

SOMBRERO, the name of an uninhabited island in the West Indies in the form of an hat, whence the name is derived. It is also the name of one of the Nicobar islands in the East Indies.

Wonderful Plant of SOMBRERO, is a strange kind of sensitive plant growing in the East Indies, in sandy bays and in shallow water. It appears like a slender straight stick; but when you attempt to touch it, immediately withdraws itself into the sand. Mr Miller gives an account of it in his description of Sumatra. He says, the Malays call it *lolan lout*, that is, sea grass. He never could observe any tentacula; but, after many unsuccessful attempts, drew out a broken piece about a foot long. It was perfectly straight and uniform, and resembled a worm drawn over a knitting needle. When dry it appears like a coral.

Philosophical Transactions, vol. lxviii. p. 178.

SOMERS, JOHN, lord high chancellor of England, was born at Worcester in 1652. He was educated at Oxford, and afterwards entered himself at the Middle-Temple, where he studied the law with great vigour. In 1688 he was one of the counsel for the seven bishops at their trial, and argued with great learning and eloquence against the dispensing power. In the convention which met by the prince of Orange's summons, January 22. 1689, he represented Worcester; and was one of the managers for the House of Commons, at a conference with the House of Lords upon the word *abdicated*. Soon after the accession of King William and Queen Mary to the throne, he was appointed solicitor-general, and received the honour of knighthood. In 1692 he was made attorney general, and in 1693 advanced to the post of lord keeper of the great seal of England. In 1695 he proposed an expedient to prevent the practice of clipping the coin. In 1697 he was created lord Somers, baron of Evesham, and made lord high chancellor of England. In the beginning of 1700 he was removed from his post of lord chancellor, and the year after was impeached of high crimes and misdemeanors by the House of Commons, of which he was acquitted upon trial by the House of Lords. He then retired to a studious course of life, and was chosen president of the Royal Society. In 1706 he proposed a bill for the regulation of the law; and the same year was one of the principal managers for the union between England and Scotland. In 1708 he was made lord president of the council; from which post he was removed in 1710, upon the change of the ministry. In the latter end of Queen Anne's reign his lordship grew very infirm in his health; which is supposed to be the reason that he held no other post than a seat at the council-table, after the accession of King George I. He died of an apoplectic fit in 1716. Mr Addison has drawn his character very beautifully in the Freeholder.

SOMERSETSHIRE, a county of England, taking its name from Somerton, once the capital, between 50° and 51° 27′ north latitude, and between 1° 25′ and 2° 59′ west longitude. It is bounded on the west by Devonshire, on the south by Dorsetshire, on the north by Bristol channel or the Severn sea, on the north east by a small part of Gloucestershire, and on the east by Wiltshire. It is one of the largest counties in England, extending in length from east to west about 68 miles; in breadth, where broadest, from south to north, about 47; and 240 in circumference. It is divided into 42 hundreds, in which are 3 cities, 32 market-towns, 1700 villages, 385 parishes of which 132 are vicarages, containing more than 1,000,000 of acres, and about 273,750 souls. It sends 18 members to parliament, viz. two for the county, two for Bristol, two for Bath, two for Wells, two for Taunton, two for Bridgewater, two for Ilchester, two for Milbourn-port, and two for Minehead.

The air of this county is very mild and wholesome, especially that of the hilly part. The soil in general is exceeding rich, so that single acres very commonly produce forty or fifty bushels of wheat, and there have been instances of some producing sixty of barley. As there is very fine pasture both for sheep and black cattle, it abounds in both, which are as large as those of Lincolnshire, and their flesh of a finer grain. In consequence of this abundance of black cattle, great quantities of cheese are made in it, of which that of Cheddar is thought equal to Parmesan. In the hilly parts are found coal, lead, copper, and lapis calaminaris. Wood thrives in it as well as in any county of the kingdom. It abounds also in pease, beans, beer, cyder, fruit, wildfowl, and salmon; and its mineral waters are celebrated all over the world.

The riches of this county, both natural and acquired, exceed those of any other in the kingdom, Middlesex and Yorkshire excepted. The woollen manufacture in all its branches is carried on to a very great extent; and in some parts of the county great quantities of linen are made. If to these the produce of various other commodities in which it abounds is added, the amount of the whole must undoubtedly be very great. Its foreign trade must also be allowed to be very extensive, when it is considered that it has a large trade for sea-coal, and possesses, besides other ports, that of Bristol, a town of the greatest trade in England, next to London.

Besides small streams, it is well watered and supplied with fish by the rivers Severn, Avon, Parrel, Froome, Ax, Torre, and Tone. Its greatest hills are Mendip, Pouldon, and Quantock, of which the first abounds in coal, lead, &c. The rivers Severn and Parrel breed very fine salmon. The chief town is Bristol.

SOMERTON, an ancient town in Somersetshire, from whence the county derives its name. It is 123 miles from London; it has five streets, containing 251 houses, which are mostly built of the blue stone from the quarries in the neighbourhood. It is governed by constables, and has a hall for petty sessions. The market

ket for corn is confiderable, and it has feveral fairs for cattle. The church has, what is not very frequent, an *octangular* tower with fix bells. N. Lat. 51. 4. W. Long. 1. 53.

SOMNAMBULI, perfons who walk in their fleep. See SLEEPWALKERS.

SOMNER, WILLIAM, an eminent Englifh antiquary, was born at Canterbury in 1606. His firft treatife was The Antiquities of Canterbury, which he dedicated to Archbifhop Laud. He then applied himfelf to the ftudy of the Saxon language; and having made himfelf mafter of it, he perceived that the old gloffary prefixed to Sir Roger Twifden's edition of the laws of King Henry I. printed in 1644, was faulty in many places; he therefore added to that edition notes and obfervations valuable for their learning, with a very ufeful gloffary. His Treatife of Gavelkind was finifhed about 1648, though not publifhed till 1660. Our author was zealoufly attached to King Charles I. and in 1648 he publifhed a poem on his fufferings and death. His fkill in the Saxon tongue led him to inquire into moft of the European languages ancient and modern. He affifted Dugdale and Dodfworth in compiling the *Monafticon Anglicanum*. His Saxon Dictionary was printed at Oxford in 1659. He died in 1669.

SON, an appellation given to a male child confidered in the relation he bears to his parents. See PARENT and FILIAL *Piety*.

SONATA, in *Mufic*, a piece or compofition, intended to be performed by inftruments only; in which fenfe it ftands oppofed to *cantata*, or a piece defigned for the voice. See CANTATA.

The fonata then, is properly a grand, free, humorous compofition, diverfified with a great variety of motions and expreffions, extraordinary and bold ftrokes, figures, &c. And all this purely according to the fancy of the compofer; who, without confining himfelf to any general rules of counterpoint, or to any fixed number or meafure, gives a loofe to his genius, and runs from one mode, meafure, &c. to another, as he thinks fit. This fpecies of compofition had its rife about the middle of the 17th century; thofe who have moft excelled in it were Baffani and Corelli. We have fonatas of 1, 2, 3, 4, 5, 6, 7, and even 8 parts, but ufually they are performed by a fingle violin, or with two violins, and a thorough bafs for the harpfichord; and frequently a more figured bafs for the bafs viol, &c.

There are a thoufand different fpecies of fonatas; but the Italians ufually reduce them to two kinds. *Suonate de chiefa*, that is, fonatas proper for church mufic, which ufually begin with a grave folemn motion, fuitable to the dignity and fanctity of the place and the fervice, after which they ftrike into a brifker, gayer, and richer manner. Thefe are what they more peculiarly call fonatas. *Suonate de camera*, or fonatas for the chamber, are properly feriefes of feveral little pieces, for dancing, only compofed to the fame tune. They ufually begin with a prelude or little fonata, ferving as an introduction to all the reft: afterwards come the allemand, pavane, courant, and other ferious dances; then jigs, gavots, minuets, chacons, paffecailles, and other gayer airs: the whole compofed in the fame tune or mode

SONCHUS, SOW-THISTLE, in *Botany*, a genus of plants belonging to the clafs of *fyngenefia*, and to the order of *polygamia æqualis*; and in the natural fyftem ranged under the 49th order, *Compofitæ*. The receptacle is naked; the calyx is imbricated, bellying and conical; the down of the feed is fimple, feffile, and very foft; the feed is oval and pointed. There are 13 fpecies; the maritimus, paluftris, fruticofus, arvenfis, oleraceus, tenerrimus, plumieri, alpinus, floridanus, fibiricus, tataricus, tuberofus, and canadenfis. Four of thefe are natives of Britain.—1. *Paluftris*, marfh fow-thiftle. The ftem is erect, from fix to ten feet high, branched and hairy towards the top: the leaves are firm, broad, half pinnated, ferrated, and fharp-pointed; the lower ones fagittate at the bafe: the flowers are of a deep yellow, large, and difperfed on the tops of the branches: the calyx is rough. It is frequent in marfhes, and flowers in July or Auguft.—2. *Arvenfis*, corn fow-thiftle. The leaves are alternate, runcinate, and heart-fhaped at the bafe; the root creeps under ground; the ftem is three or four feet high, and branched at the top. It grows in corn-fields, and flowers in Auguft.—3. *Oleraceus*, common fow-thiftle. The ftalk is fucculent, piftular, and a cubit high or more; the leaves are broad, embracing the ftem, generally deeply finuated, fmooth, or prickly at the edges; the flowers are of a pale yellow, numerous, in a kind of umbel, and terminal; the calyx is fmooth. It is frequent in wafte places and cultivated grounds.—4. *Alpinus*, blue-flowered fow-thiftle. The ftem is erect, purplifh, branched, or fimple, from three to fix feet high: the leaves are large, fmooth, and finuated; the extreme fegment large and triangular: the flowers are blue, and grow on hairy vifcid pedicles, in long fpikes: the calyx is brown. This fpecies is found in Northumberland.

SONG, in *Poetry*, a little compofition, confifting of eafy and natural verfes, fet to a tune in order to be fung. See POETRY, N° 120.

SONG, in *Mufic*, is applied in general to a fingle piece of mufic, whether contrived for the voice or an inftrument. See AIR.

SONG of Birds, is defined by the honourable Daines Barrington to be a fucceffion of three or more different notes, which are continued without interruption, during the fame interval, with a mufical bar of four crotchets in an adagio movement, or whilft a pendulum fwings four feconds.

It is affirmed, that the notes of birds are no more innate than language in man, and that they depend upon imitation, as far as their organs will enable them to imitate the founds which they have frequent opportunities of hearing: and their adhering fo fteadily, even in a wild ftate, to the fame fong, is owing to the neftlings attending only to the inftruction of the parent bird, whilft they difregard the notes of all others that may perhaps be finging round them.

Birds in a wild ftate do not commonly fing above 10 weeks in the year, whereas birds that have plenty of food in a cage fing the greateft part of the year; and we may add, that the female of no fpecies of birds ever fings. This is a wife provifion of nature, becaufe her fong would difcover her neft. In the fame manner, we may rationally account for her inferiority in plumage. The faculty of finging is confined to the cock birds; and accordingly Mr Hunter, in diffecting birds of feveral fpecies, found the mufcles of the larynx to be

Song.

ſtronger in the nightingale than in any other bird of the ſame ſize; and in all thoſe inſtances, where he diſſected both cock and hen, the ſame muſcles were ſtronger in the cock. To the ſame purpoſe, it is an obſervation as ancient as the time of Pliny, that a capon does not crow.

Some have aſcribed the ſinging of the cock-bird in the ſpring ſolely to the motive of pleaſing his mate during incubation; others, who allow that it is partly for this end, believe it is partly owing alſo to another cauſe, viz. the great abundance of plants and inſects in the ſpring, which, as well as ſeeds, are the proper food of ſinging birds at that time of the year.

Mr Barrington remarks, that there is no inſtance of any ſinging bird which exceeds our blackbird in ſize; and this, he ſuppoſes, may ariſe from the difficulty of its concealing itſelf, if it called the attention of its enemies, not only by its bulk, but by the proportionable loudneſs of its notes. This writer farther obſerves, that ſome paſſages of the ſong in a few kinds of birds correſpond with the intervals of our muſical ſcale, of which the cuckoo is a ſtriking and known inſtance; but the greater part of their ſong cannot be reduced to a muſical ſcale; partly, becauſe the rapidity is often ſo great, and it is alſo ſo uncertain when they may ſtop, that we cannot reduce the paſſages to form a muſical bar in any time whatſoever; partly alſo, becauſe the pitch of moſt birds is conſiderably higher than the moſt ſhrill notes of thoſe inſtruments which have the greateſt compaſs; and principally, becauſe the intervals uſed by birds are commonly ſo minute, that we cannot judge of them from the more groſs intervals into which we divide our muſical octave. This writer apprehends, that all birds ſing in the ſame key; and in order to diſcover this key, he informs us, that the following notes have been obſerved in different birds, A, B flat, C, D, F, and G; and therefore E only is wanting to complete the ſcale: now theſe intervals, he ſays, can only be found in the key of F with a ſharp third, or that of G with a flat third; and he ſuppoſes it to be the latter, becauſe admitting that the firſt muſical notes were learned from birds, thoſe of the cuckoo, which have been moſt attended to, form a flat third, and moſt of our compoſitions are in a flat third, where muſic is ſimple, and conſiſts merely of melody. As a farther evidence that birds ſing always in the ſame key, it has been found by attending to a nightingale, as well as a robin which was educated under him, that the notes reducible to our intervals of the octave were always preciſely the ſame.

Moſt people, who have not attended to the notes of birds, ſuppoſe, that every ſpecies ſing exactly the ſame notes and paſſages: but this is by no means true; though it is admitted that there is a general reſemblance. Thus the London bird-catchers prefer the ſong of the Kentiſh goldfinches, and Eſſex chaffinches; and ſome of the nightingale fanciers prefer a Surry bird to thoſe of Middleſex.

Of all ſinging birds, the ſong of the nightingale has been moſt univerſally admired: and its ſuperiority (deduced from a caged bird) conſiſts in the following particulars; its tone is much more mellow than that of any other bird, though at the ſame time, by a proper exertion of its muſical powers, it can be very brilliant. Another point of ſuperiority is its continuance of ſong without a pauſe, which is ſometimes no leſs than 20 ſeconds; and when reſpiration becomes neceſſary, it takes it with as much judgment as an opera-ſinger. The ſky-lark in this particular, as well as in compaſs and variety, is only ſecond to the nightingale. The nightingale alſo ſings (if the expreſſion may be allowed) with ſuperior judgment and taſte. Mr Barrington has obſerved, that his nightingale, which was a very capital bird, began ſoftly like the ancient orators, reſerving its breath to ſwell certain notes, which by theſe means had a moſt aſtoniſhing effect. This writer adds, that the notes of birds, which are annually imported from Aſia, Africa, and America, both ſingly and in concert, are not to be compared to thoſe of European birds.

Song ‖ Soontaburdar.

The following table, formed by Mr Barrington, agreeably to the idea of M. de Piles in eſtimating the merits of painters, is deſigned to exhibit the comparative merit of the Britiſh ſinging birds; in which 20 is ſuppoſed to be the point of abſolute perfection.

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	Mellowneſs of tone.	Sprightly notes	Plaintive notes.	Compaſs.	Execution.
Nightingale - -	19	14	19	19	19
Sky-lark - -	4	19	4	18	18
Wood-lark - -	18	4	17	12	8
Tit-lark - -	12	12	12	12	12
Linnet - - -	12	16	12	16	18
Goldfinch - -	4	19	4	12	12
Chaffinch - -	4	12	4	8	8
Greenfinch - -	4	4	4	4	6
Hedge-ſparrow -	6	0	6	4	4
Aberdavine or ſiſkin	2	4	0	4	4
Red-poll - -	0	4	0	4	4
Thruſh - -	4	4	4	4	4
Blackbird - -	4	4	0	2	2
Robin - - -	6	16	12	12	14
Wren - -	0	12	0	4	2
Reed ſparrow - -	0	4	0	2	2
Black cap, or Norfolk mock nightingale	14	12	12	14	14

SONNA, a book of Mahometan traditions, which the orthodox muſſulmans are required to believe.

SONNERATIA, a genus of plants belonging to the claſs of *icoſandria*, and to the order of *monogynia*. See Botany *Index*.

SONNET, in *Poetry*, a compoſition contained in 14 verſes, viz. two ſtanzas or meaſures of four verſes each, and two of three, the firſt eight verſes being all in three rhimes.

SONNITES, among the Mahometans, an appellation given to the orthodox muſſulmans or true believers; in oppoſition to the ſeveral heretical ſects, particularly the Shiites, or followers of Ali.

SOOJU, or Soy. See Dolichos.

SOONTABURDAR, in the Eaſt Indies; an attendant, who carries a ſilver bludgeon in his hand about two or three feet long, and runs before the palanquin. He is inferior to the chubdar; the propriety of an Indian newaury requiring two ſoontaburdars for every chubdar in the train. The chubdar proclaims the approach of viſitors, &c. He generally carries a large ſilver-ver ftaff about five feet long in his hands; and among the Nabobs he proclaims their praifes aloud as he runs before their palanquins.

SOOT, a volatile matter arifing from wood and other fuel along with the fmoke; or rather, it is the fmoke itfelf condenfed and gathered to the fides of the chimney. Though once volatile, however, foot cannot be again refolved into vapour; but, if diftilled by a ftrong fire, yields a volatile alkali and empyreumatic oil, a confiderable quantity of fixed matter remaining at the bottom of the diftilling veffel. If burnt in an open fire, it flames with a thick fmoke, whence other foot is produced. It is ufed as a material for making fal ammoniac, and as a manure. See AMMONIA, *muriate of*, CHEMISTRY *Index*.

SOOT-Black. See *COLOUR-Making.*

SOPHI, or SOFI, a title given to the emperor of Perfia, importing as much as wife, fage, or philofopher.

The title is by fome faid to have taken its rife from a young fhepherd named *Sophi*, who attained to the crown of Perfia in 1370; others derive it from the *fophoi* or fages anciently called *magi*. Voffius gives a different account of the word: fophi in Arabic, he obferves, fignifies *wool;* and he adds, that it was applied by the Turks out of derifion to the kings of Perfia ever fince Ifhmael's time; becaufe, according to their fcheme of religion, he is to wear no other covering on his head but an ordinary red woollen ftuff; whence the Perfians are alfo called *hezelbafchs*, q. d. *red-heads*. But Bochart affures us, that fophi in the original Perfian language, fignifies one that is pure in his religion, and who prefers the fervice of God in all things: and derives it from an order of religious called by the fame name. The fophis value themfelves on their illuftrious extraction. They are defcended in a right line from Houffein, fecond fon of Ali, Mahomet's coufin, and Fatima, Mahomet's daughter.

SOPHIS, or *Sofees*, a kind of order of religious among the Mahometans in Perfia, anfwering to what are otherwife called *dervifes*, and among the Arabs and Indians *faquirs*. Some will have them called fophis from a kind of coarfe camblet which they wear, called *fouf*, from the city Souf in Syria, where it is principally manufactured. The more eminent of thofe fophis are complimented with the title *fchick*, that is, *reverend*, much as in Romifh countries the religious are called *reverend fathers*. Schick Sophi, who laid the foundation of the grandeur of the royal houfe of Perfia, was the founder, or rather the reftorer of this order: Ifhmael, who conquered Perfia, was himfelf a fophi, and greatly valued himfelf on his being fo. He chofe all the guards of his perfon from among the religious of this order; and would have all the great lords of his court fophis. The king of Perfia is ftill grandmafter of the order; and the lords continue to enter into it, though it be now fallen under fome contempt.

SOPHISM, in *Logic*, a fpecious argument having the appearance of truth, but leading to falfehood. Sophifms are reduced by Ariftotle into eight claffes, an arrangement fo juft and comprehenfive, that it is equally proper in prefent as in former times. 1. *Ignoratio elenchi*, in which the fophift feems to determine the queftion, while he does it only in appearance. Thus the queftion, "Whether the excefs of wine be hurtful?" feems to be determined by proving, that wine revives the fpirits and gives a man courage: but the principal point is here kept out of fight; for ftill it may be hurtful to health, to fortune, and reputation. 2. *Petitio principii*, a begging of the queftion, or taking for granted that which remains to be proved, as if any one fhould undertake to prove that the foul is extended through all the parts of the body, becaufe it refides in every member. This is affirming the fame thing in different words. 3. Reafoning in a circle; as when the Roman Catholics prove the Scriptures to be the word of God by the authority of the church, and the authority of the church from the Scriptures. 4. *Non caufa pro caufa*, or the affigning of a falfe caufe to any effect. Thus the fuppofed principle, that nature abhors a vacuum, was applied to explain the rifing of water in a pump before Galileo difcovered that it was owing to the preffure of the atmofphere. In this way the vulgar afcribe accidents to divine vengeance, and the herefies and infidelity of modern times are faid to be owing to learning. 5. *Fallacia accidentis*, in which the fophift reprefents what is merely accidental as effential to the nature of the fubject. This is nearly allied to the former, and is committed by the Mahometans and Roman Catholics. The Mahometans forbid wine, becaufe it is fometimes the occafion of drunkennefs and quarrels; and the Roman Catholics prohibit the reading of the Bible, becaufe it has fometimes promoted herefies. 6. By deducing an univerfal affertion from what is true only in particular circumftances, and the reverfe: thus fome men argue, "tranfcribers have committed many errors in copying the Scriptures, therefore they are not to be depended on." 7. By afferting any thing in a compound fenfe which is only true in a divided fenfe; fo when the Scriptures affure us, that the worft of finners may be faved, it does not mean that they fhall be faved while they remain finners, but that if they repent they may be faved. 8. By an abufe of the ambiguity of words. Thus Mr Hume reafons in his Effay on Miracles: "Experience is our only guide in reafoning concerning matters of fact; now we know from experience, that the laws of nature are fixed and invariable. On the other hand, teftimony is variable and often falfe; therefore fince our evidence for the reality of miracles refts folely on teftimony which is variable, and our evidence for the uniformity of the laws of nature is invariable, miracles are not to be believed." The fophiftry of this reafoning depends on the ambiguity of the word *experience*, which in the firft propofition fignifies the maxims which we form from our own obfervation and reflection; in the fecond it is confounded with teftimony; for it is by the teftimony of others, as well as our own obfervation, that we learn whether the laws of nature are variable or invariable. The Effay on Miracles may be recommended to thofe who wifh to fee more examples of fophiftry; as we believe moft of the eight fpecies of fophifms which we have mentioned are well illuftrated by examples in that effay.

SOPHIST, an appellation affumed in the early periods of Grecian hiftory by thofe who devoted their time to the ftudy of fcience. This appellation appearing too arrogant to Pythagoras, he declined it, and wifhed to be called a *philofopher;* declaring that, though he could not confider himfelf as a wife man, he was indeed a lover of wifdom. True wifdom and modefty are generally united. The example of Pythagoras was followed by every man of eminence; while the name *sophist* was retained only by those who with a pomp of words made a magnificent display of wisdom upon a very slight foundation of knowledge. Those men taught an artificial structure of language, and a false method of reasoning, by which, in argument, the worse might be made to appear the better reason (see SOPHISM). In Athens they were long held in high repute, and supported, not only by contributions from their pupils, but by a regular salary from the state. They were among the bitterest enemies of the illustrious Socrates, because he embraced every opportunity of exposing to contempt and ridicule their vain pretensions to superior knowledge, and the pernicious influence of their doctrines upon the taste and morals of the Athenian youth.

SOPHISTICATION, the mixing of any thing with what is not genuine; a practice too common in the making up of medicines for sale; as also among vintners, distillers, and others, who are accused of sophisticating their wines, spirits, oils, &c. by mixing with them cheaper and coarser materials; and in many cases the cheat is carried on so artfully as to deceive the best judges.

SOPHOCLES, the celebrated Greek tragic poet, the son of Sophilus an Athenian, was born at Colonn, and educated with great attention. Superior vigour and address in the exercises of the palestra, and skill in music, were the great accomplishments of young men in the states of Greece. In these, Sophocles excelled; nor was he less distinguished by the beauty of his person. He was also instructed in the noblest of all sciences, civil polity and religion: from the first of these he derived an unshaken love of his country, which he served in some embassies, and in high military command with Pericles; from the latter he was impressed with a pious reverence for the gods, manifested by the inviolable integrity of his life. But his studies were early devoted to the tragic muse; the spirit of Eschylus lent a fire to his genius, and excited that noble emulation which led him to contend with, and sometimes to bear away the prize from, his great master. He wrote 43 tragedies, of which 7 only have escaped the ravages of time: and having testified his love of his country by refusing to leave it, though invited by many kings; and having enjoyed the uninterrupted esteem and affection of his fellow-citizens, which neither the gallant actions and sublime genius of Eschylus, nor the tender spirit and philosophic virtue of Euripides, could secure to them, he died in the 91st year of his age, about 406 years before Christ. The burial-place of his ancestors was at Decelia, which the Lacedemonians had at that time seized and fortified; but Lysander, the Spartan chief, permitted the Athenians to inter their deceased poet; and they paid him all the honours due to his love of his country, integrity of life, and high poetic excellence. Eschylus had at once seized the highest post of honour in the field of poetry, the true sublime; to that eminence his claim could not be disputed. Sophocles had a noble elevation of mind, but tempered with so fine a taste, and so chastened a judgement, that he never passed the bounds of propriety. Under his conduct the tragic muse appeared with the chaste dignity of some noble matron at a religious solemnity; harmony is in her voice, and grace in all her motions. From him the theatre received some additional embellishments; and the drama the introduction of a third speaker, which made it more active and interesting: but his distinguished excellence is in the judicious disposition of the fable, and so nice a connection and dependence of the parts on each other, that they all agree to make the event not only probable, but even necessary. This is peculiarly admirable in his "Oedipus King of Thebes;" and in this important point he is far superior to every other dramatic writer.

The ingratitude of the children of Sophocles is well known. They wished to become immediate masters of their father's possessions; and therefore tired of his long life, they accused him before the Areopagus of insanity. The only defence the poet made was to read his tragedy of Oedipus at Colonos, which he had lately finished; and then he asked his judges, whether the author of such a performance could be taxed with insanity! The father upon this was acquitted, and the children returned home covered with shame and confusion. The seven tragedies of Sophocles which still remain, together with the Greek Scholia which accompany them, have been translated into Latin by Johnson, and into English by Dr Franklin and Mr Potter.

SOPHORA, a genus of plants belonging to the class of decandria, and to the order of monogynia; and in the natural system arranged under the 32d order, *Papilionaceæ*. See BOTANY *Index*.

SOPORIFIC, or SOPORIFEROUS, a medicine that produces sleep. Such are opium, laudanum, the seed of poppies, &c. The word is formed from the Latin *sopor* "sleep." The Greeks in place of it use the word *hypnotic*.

SORBONNE, or SORBON, the house or college of the faculty of theology established in the university of Paris. It was founded in 1252 by St Louis, or rather by Robert de Sorbon his confessor and almoner, first canon of Cambray, and afterwards of the church of Paris; who gave his own name to it, which he himself took from the village of Sorbon or Serbon, near Sens, where he was born. The foundation was laid in 1250; Queen Blanche, in the absence of her husband, furnishing him with a house which had formerly been the palace of Julian the apostate, of which some remains are still seen. Afterwards the king gave him all the houses he had in the same place, in exchange for some others. The college has been since magnificently rebuilt by the cardinal de Richelieu. The design of its institution was for the use of poor students in divinity. There are lodgings in it for 36 doctors, who are said to be of the *society of the Sorbonne*; those admitted into it without being doctors, are said to be of the *hospitality of the Sorbonne*. Six regent doctors formerly held lectures every day for an hour and a half each; three in the morning, and three in the afternoon.

SORBONNE, is also used in general for the whole faculty of theology at Paris; as the assemblies of the whole body are held in the house of the Sorbonne; and the bachelors of the other houses of the faculty, as the house of Navarre, &c. come hither to hold their *sorbonnique*, or act for being admitted doctor in divinity.

SORBUS, SERVICE-TREE, a genus of plants belonging to the class of icosandria, and to the order of trigynia. See BOTANY *Index*.—The *aucuparia*, mountain-ash, quicken-tree, quick-beam, or roan-tree, rises with a a ſtraight upright ſtem and regular branching head, twenty or thirty feet high or more, covered with a ſmooth grayiſh brown bark; pinnated leaves of eight or ten pair of long, narrow, ſerrated folioles, and an odd one, ſmooth on both ſides; and large umbellate cluſters of white flowers at the ſides and ends of the branches, ſucceeded by cluſters of fine red berries, ripe in autumn and winter. There is a variety with yellow ſtriped leaves. This ſpecies grows wild in many parts of this iſland in mountainous places, woods, and hedge-rows, often growing to the ſize of timber; and is admitted into moſt ornamental plantations, for the beauty of its growth, foliage, flowers, and fruit; the latter, in particular, being produced in numerous red large bunches all over the tree, exhibit a fine appearance in autumn and winter, till devoured by the birds, eſpecially the blackbird and thruſh, which are ſo allured by this fruit as to flock from all parts and feed on it voraciouſly.—In the iſland of Jura the juice of the berries is employed as an acid for punch. It is probable that this tree was in high eſteem with the Druids; for it is more abundant than any other tree in the neighbourhood of thoſe Druidical circles of ſtones, ſo common in North Britain. It is ſtill believed by ſome perſons, that a branch of this tree can defend them from enchantment or witchcraft. Even the cattle are ſuppoſed to be preſerved by it from danger. The dairy-maid drives them to the ſummer paſtures with a rod of the roan-tree, and drives them home again with the ſame. In Strathſpey, we are told, a hoop is made of the wood of this tree on the 1ſt of May, and all the ſheep and lambs are made to paſs through it.

The *domeſtica*, or cultivated ſervice-tree, with eatable fruit, grows with an upright ſtem, branching 30 or 40 feet high or more, having a browniſh bark, and the young ſhoots in ſummer covered with a mealy down; pinnated leaves of eight or ten pair of broadiſh deeply ſerrated lobes and an odd one, downy underneath; and large umbellate cluſters of white flowers at the ſides and ends of the branches, ſucceeded by bunches of large, fleſhy, edible red fruit, of various ſhapes and ſizes. This tree is a native of the ſouthern warm parts of Europe, where its fruit is uſed at table as a deſert, and it is cultivated here in many of our gardens, both as a fruit-tree and as an ornament to diverſify hardy plantations.

SORCERY, or MAGIC; the power which ſome perſons were formerly ſuppoſed to poſſeſs of commanding the devil and the infernal ſpirits by ſkill in charms and invocations, and of ſoothing them by fumigations. Sorcery is therefore to be diſtinguiſhed from witchcraft; an art which was ſuppoſed to be practiſed, not by commanding evil ſpirits, but by compact with the devil. As an inſtance of the power of bad ſmells over demons or evil ſpirits, we may mention the flight of the evil ſpirit mentioned in Tobit into the remote parts of Egypt, produced, it is ſaid, by the ſmell of the burnt liver of a fiſh. Lilly informs us, that one Evans having raiſed a ſpirit at the requeſt of Lord Bothwell and Sir Kenelm Digby, and forgetting a fumigation, the ſpirit, vexed at the diſappointment, pulled him without the circle, and carried him from his houſe in the Minories into a field near Batterſea Cauſeway.

King James, in his *Dæmonologia*, has given a very full account of the art of ſorcery. "Two principal things (ſays he) cannot well in that errand be wanted: holy water (whereby the devill mockes the papiſts), and ſome preſent of a living thing unto him. There are likewiſe certaine daies and houres that they obſerve in this purpoſe. Theſe things being all ready and prepared, circles are made, triangular, quadrangular, round, double, or ſingle, according to the forme of the apparition they crave. When the conjured ſpirit appeares, which will not be while after many circumſtances, long prayers, and much muttering and murmurings of the conjurors, like a papiſt prieſt diſpatching a hunting maſſe—how ſoone, I ſay, he appeares, if they have miſſed one jote of all their rites; or if any of their feete once ſlyd over the circle, through terror of his fearfull apparition, he paies himſelf at that time, in his owne hand, of that due debt which they ought him, and otherwiſe would have delaied longer to have paied him: I mean, he carries them with him, body and ſoule." How the conjurors made triangular or quadrangular circles, his majeſty has not informed us, nor does he ſeem to imagine there was any difficulty in the matter. We are therefore led to ſuppoſe, that he learned his mathematics from the ſame ſyſtem as Dr Sacheverell, who, in one of his ſpeeches or ſermons, made uſe of the following ſimile: "They concur like parallel lines, meeting in one common centre."

Another mode of conſulting ſpirits was by the beryl, by means of a ſpeculator or ſeer; who, to have a complete ſight, ought to be a pure virgin, a youth who had not known woman, or at leaſt a perſon of irreproachable life and purity of manners. The method of ſuch conſultation is this: The conjuror having repeated the neceſſary charms and adjurations, with the litany or invocation peculiar to the ſpirits or angels he wiſhes to call (for every one has his particular form), the ſeer looks into a cryſtal or beryl, wherein he will ſee the anſwer, repreſented either by types or figures; and ſometimes, though very rarely, will hear the angels or ſpirits ſpeak articulately. Their pronunciation is, as Lilly ſays, like the Iriſh, much in the throat. Lilly deſcribes one of theſe beryls or cryſtals. It was, he ſays, as large as an orange, ſet in ſilver, with a croſs at the top, and round about engraved the names of the angels Raphael, Gabriel, and Uriel. A delineation of another is engraved in the frontiſpiece to Aubery's Miſcellanies.

Theſe ſorcerers or magicians do not always employ their art to do miſchief; but, on the contrary, frequently exert it to cure diſeaſes inflicted by witches; to diſcover thieves; recover ſtolen goods; to foretel future events, and the ſtate of abſent friends. On this account they are frequently called *white witches*. See MAGIC, WITCHCRAFT, &c.

Our forefathers were ſtrong believers when they enacted, by ſtatute 33 Hen. VIII. c. 8. all witchcraft and ſorcery to be felony without benefit of clergy; and again, by ſtatute 1 Jac. I. c. 12. that all perſons invoking any evil ſpirit, or conſulting, covenanting with, entertaining, employing, feeding, or rewarding any evil ſpirit; or taking up dead bodies from their graves to be uſed in any witchcraft, ſorcery, charm, or inchantment; or killing or otherwiſe hurting any perſon by ſuch infernal arts; ſhould be guilty of felony without benefit of clergy, and ſuffer death. And if any perſon ſhould attempt by ſorcery to diſcover hidden treaſure, or to reftore ftolen goods, or to provoke unlawful love, or to hurt any man or beaft, though the fame were not effected, he or fhe fhould fuffer imprifonment and pillory for the firft offence, and death for the fecond. Thefe acts continued in force till lately, to the terror of all ancient females in the kingdom; and many poor wretches were facrificed thereby to the prejudice of their neighbours and their own illufions, not a few having by fome means or other confeffed the fact at the gallows. But all executions for this dubious crime are now at an end; our legiflature having at length followed the wife example of Louis XIV. in France, who thought proper by an edict to reftrain the tribunals of juftice from receiving informations of witchcraft. And accordingly it is with us enacted, by ftatute 9 Geo. II. c. 5. that no profecution fhall for the future be carried on againft any perfon for conjuration, witchcraft, forcery, or inchantment: But the mifdemeanor of perfons pretending to ufe witchcraft, tell fortunes, or difcover ftolen goods, by fkill in the occult fciences, is ftill defervedly punifhed with a year's imprifonment, and ftanding four times in the pillory.

SOREX, the SHREW, a genus of animals belonging to the clafs of *mammalia*, and order of *feræ*. See MAMMALIA *Index*.

SORITES, in *Logic*, a fpecies of reafoning in which a great number of propofitions are fo linked together, that the predicate of the one becomes continually the fubject of the next following, till at laft a conclufion is formed by bringing together the fubject of the firft propofition and the predicate of the laft. Such was that merry argument of Themiftocles, to prove that his little fon under ten years old governed the whole world. Thus: *My fon governs his mother; his mother me; I the Athenians; the Athenians the Greeks; Greece commands Europe; Europe the whole world: therefore my fon commands the whole world.* See LOGIC, N° 96, 97.

SORNING, in *Scots Law*. See LAW, N° clxxxvi. 30.

SORREL, in *Botany*, a fpecies of the RUMEX, which grows in paftures and meadows, and is well known. The natives of Lapland boil large quantities of the leaves in water, and mix the juice when cold with the milk of their rein-deer, which they efteem an agreeable and wholefome food. The Dutch are faid to cultivate this plant for its ufefulnefs in the dyeing of woollen cloths black; and we know that by means of the common broad-leaved forrel an excellent black colour is, in many places of Scotland, given to woollen ftuffs without the aid of copperas. As this mode of dyeing does not in the fmalleft degree injure the texture of the cloth, which continues to the laft foft and filky, without that hardnefs to the touch which it acquires when dyed black by means of copperas, our readers will probably thank us for the following receipt, with which we have been favoured by a learned phyfician:

Let the ftuff to be dyed be well wafhed with foap and water, and afterwards completely dried. Then of the common broad-leaved forrel boil as much as fhall make an acid decoction of fufficient quantity to let the ftuff to be dyed lie in it open and eafy to be ftirred. The greater quantity of forrel that is ufed, the better will the colour be; and therefore if the pot or cauldron will not hold enough at once, when part has been fufficiently boiled, it muft be taken out and wrung, and a frefh quantity be boiled in the fame juice or decoction. When the liquor is made fufficiently acid, ftrain it from the forrel through a fieve, put the cloth or yarn into it, and let it boil for two hours, ftirring it frequently. If ftockings be among the ftuff to be dyed, it will be expedient, after they have been an hour in the boiling liquor, to turn them infide out, and at the end of the fecond hour let the whole be poured into a tub or any other veffel. The pot or cauldron muft then be wafhed, and water put into it, with half a pound of logwood chips for every pound of dry yarn or cloth. The logwood and water fhould boil flowly for four hours; and then the cloth or yarn being wrung from the four liquor, and put into the logwood decoction, the whole muft be fuffered to boil flowly for four hours, ftockings, if there be any, being turned infide out at the end of two hours. Of this laft decoction there muft, as of the former, be enough to let the cloth lie open and eafy to be ftirred while boiling. At the end of the four hours the cloth muft be taken out, and among the boiling liquor, firft removed from the fire, muft be poured a Scotch pint or half an Englifh gallon of ftale urine for every pound of dry cloth or other ftuff to be dyed. When this compound liquor has been ftirred and become cold, the cloth muft be put into it and fuffered to remain well covered for 12 hours, and then dried in the fhade; after which, to diveft it of fmell or any other impurity, it may be wafhed in cold water, and dried for ufe.

Wood-SORREL. See OXALIS, BOTANY *Index*.

SORREL-Colour, in the manege, is a reddifh colour, generally thought to be a fign of a good horfe.

SORRENTO, a fea-port town of the kingdom of Naples, with an archbifhop's fee. It is feated in a peninfula, on the bay of Naples, at the foot of a mountain of the fame name, 17 miles fouth-eaft of Naples. It is the birth-place of Torquato Taffo. E. Long. 14. 24. N. Lat. 40. 36.

SORTILEGE, (*Sortilegium*) a fpecies of divination performed by means of *fortes* or lots.

The *fortes Preneftinæ*, famous in antiquity, confifted in putting a number of letters, or even whole words, into an urn; and then, after fhaking them together, they were thrown on the ground; and whatever fentences could be made out from them, conftituted the anfwer of the oracle. To this method of divination fucceeded that which has been called the *fortes Homerianæ* and *fortes Virgilianæ*, a mode of inquiring into futurity, which undoubtedly took its rife from a general cuftom of the oracular priefts of delivering their anfwers in verfe; it fubfifted a long time among the Greeks and Romans; and being from them adopted by the Chriftians, it was not till after a long fucceffion of centuries that it became exploded. Among the Romans it confifted in opening fome celebrated poet at random, and among the Chriftians the Scriptures, and drawing, from the firft paffage which prefented itfelf to the eye, a prognoftic of what would befal one's felf or others, or direction for conduct when under any exigency. There is good evidence that this was none of the vulgar errors; the greateft perfons, philofophers of the beft repute, admitted this fuperftition. Socrates, when in prifon, hearing this line of Homer,

Within three days I Phthia's fhore fhall fee,

immediately faid, within three days I fhall be out of the world;

world: gathering it from the double meaning of the word *Phthia*, which in Greek is both the name of a country and signifies corruption or death. This prediction, addressed to Æschines, was not easily forgotten, as it was verified.

When this superstition passed from Paganism into Christianity, the Christians had two methods of consulting the divine will from the Scriptures; the one, casually, to open the divine writings, and take their direction, as above mentioned; the other, to go to church with a purpose of receiving, as a declaration of the will of heaven, the words of the Scripture, which were singing at the instant of one's entrance.

This unwarrantable practice of inquiring into futurity prevailed very generally in England till the beginning of the 18th century; and sometimes the books of Scripture, and sometimes the poems of Virgil, were consulted for oracular responses. One remarkable instance is that of King Charles I. who being at Oxford during the civil wars, went one day to see the public library, where he was shown, among other books, a Virgil nobly printed and exquisitely bound. The lord Falkland, to divert the king, would have his majesty make a trial of his fortune by the *Sortes Virgilianæ*. Whereupon the king opening the book, the passage which happened to come up was this:

> *At, bello audacis populi vexatus et armis,*
> *Finibus extorris, complexu avulsus Iuli,*
> *Auxilium imploret; videatque indigna suorum*
> *Funera: nec, cum se sub leges pacis iniquæ*
> *Tradiderat, regno aut optata luce fruatur;*
> *Sed cadat ante diem, mediaque inhumatus arena.*
> Æneid, lib. iv.

> Yet let a race, untamed and haughty foes,
> His peaceful entrance with dire arms oppose;
> Oppressed with numbers in the unequal field,
> His men discouraged, and himself expelled,
> Let him for succour sue from place to place,
> Torn from his subjects, and his son's embrace:
> First let him see his friends in battle slain,
> And their untimely fate lament in vain;
> And when at length the cruel war shall cease,
> On hard conditions may he buy his peace.
> Nor let him then enjoy supreme command,
> But fall untimely by some hostile hand,
> And lie unburied on the barren sand.

Lord Falkland observing that the king was concerned at this accident, would likewise try his own fortune in the same manner, hoping he might fall upon some passage that would have no relation to his case, and thereby divert the king's thoughts from any impression which the other might have upon him; but the place he stumbled upon was as much suited to his destiny as the other had been to the king's; being the lamentation of Evander for the untimely death of his son Pallas*: for this lord's eldest son, a young man of an amiable character, had been slain in the first battle of Newbury.

* Æneid, lib. xi.

We have ourselves known several whose devotion has not always been regulated by judgement pursue this method of divination; and have generally observed, that the consequence has been despair or presumption. To such we beg leave to recommend one passage in Scripture which will never disappoint them: *Thou shalt not tempt the Lord thy God.*

SOTERIA, in antiquity, sacrifices offered to the gods for delivering a person from danger; as also poetical pieces composed for the same purpose.

SOUBISE, a town of France, in the department of Lower Charente, and late territory of Saintonge. It is seated on the river Charente, 22 miles south of Rochelle, in W. Long. 1. 2. N. Lat. 45. 57.

SOUDAN, a kingdom of Africa, situated between 11° and 16° N. Lat. and 26° and 30° E. Long. See DAR FUR.

SOUGH, among miners, denotes a passage dug under ground, to convey off waters from mines. See MINE.

SOVEREIGN, in matters of government, is applied to the supreme magistrate or magistrates of an independent government or state; because their authority is only bounded by the laws of God and the laws of the state: such are kings, princes, &c. See PREROGATIVE, &c.

SOVEREIGN Power, or *Sovereignty*, is the power of making laws; for wherever that power resides, all others must conform to it, and be directed by it, whatever appearance the outward form and administration of the government may put on. For it is at any time in the option of the legislature to alter that form and administration by a new edict or rule, and to put the execution of the laws into whatever hands it pleases: and all the other powers of the state must obey the legislative power in the execution of their several functions, or else the constitution is at an end. In our constitution the law ascribes to the king the attribute of sovereignty: but that is to be understood in a qualified sense, i. e. as supreme magistrate, not as sole legislator; as the legislative power is vested in the king, lords, and commons, not in any of the three estates alone.

SOU. See SOL.

SOUFFRIERE, a small town, situated at the bottom of a bay, near the leeward extremity of the island of St Lucia. Of itself it is not entitled to much notice, but the adjacent ground is very remarkable. The declivities of the surrounding hills are cultivated, and afford sugar-cane of a good quality.

The extremity of the south side of Souffriere bay runs into two steep hills of a conical shape, and nearly perpendicular, reckoned the highest on the island, and known by the appellation of the *Sugar-Loaf Hills*. It is impossible to ascend them; for although it was once attempted by two negroes, it is said that they never returned. Passing the hills to the windward of Souffriere, a fine level country presents itself, extending from 15 to 20 miles from the back of the Sugar-Loaf Hills along the sea coast, being wholly cultivated, and divided into rich estates. It is intersected by numerous rivers of very clear water, which, by art, are made subservient to the purpose of sugar-making. The rains here are less frequent than on any other part of the island, and the wind blows from the sea, or nearly so.

There is a volcano in the vicinity of this town. After passing one or two small hills, the smell of sulphur is sensibly felt before any vestige of the place is perceived. The first thing discerned is a rivulet of black running water, sending forth streams nearly in a state of ebullition, from which the volcano soon comes into view, situated

Soufriere li. Sounding.

tuated in a hollow, and furrounded by hills on every fide. There are many pits in the hollow, of a black and thick boiling matter, which appears to work with great force. Lava is ejected by flow degrees, and there is a large mafs of it in the centre of the hollow, forming a fort of hill. The lava is faid to be a fulphur mixed with calcareous earth and fome faline body. Small quantities of alum have been found in a perfect ftate; and there is a rivulet of good water in the opening, at the north fide of the hollow. When the bottom of it is ftirred, the water is very hot, fo much fo as not to be touched. The liquid running from the pits is ftrongly impregnated with fulphur, and very much refembles the preparation fold in the fhops, called *aqua fulphurata*.

SOUL, the principle of perception, memory, intelligence, and volition, in man; which, fince the earlieft era of philofophy, has furnifhed queftions of difficult inveftigation, and materials of keen and important controverfy (fee METAPHYSICS, Part III. chap. ii. iii. iv. v.; and RESURRECTION, N° 42—48.). In the 4th volume of the Memoirs of the Literary and Philofophical Society of Manchefter, the reader will find a very valuable paper by Dr Ferriar, proving, by evidence apparently complete, that every part of the brain has been injured without affecting the act of thought. An abridgement of that memoir would weaken its reafoning; which, built on matters of fact and experience, appears to us to have fhaken the modern theory of the Materialifts from its very foundation.

SOUL of Brutes. See BRUTES.

SOUND, in *Phyfics*, a term which expreffes a fimple idea; it is that primary information which we obtain of external things by means of the fenfe of hearing. See ACOUSTICS.

SOUND, in *Geography*, denotes in general any ftrait or inlet of the fea between two headlands. It is given by way of eminence to the ftrait between Sweden and Denmark, joining the German ocean to the Baltic. being about three miles over. See DENMARK, N° 32. and ELSINORE.

SOUND-Board, the principal part of an organ, and that which makes the whole machine play. It is a refervoir into which the wind, drawn in by the bellows, is conducted by a port-vent, and thence diftributed into the pipes placed over the holes of its upper part. The wind enters them by valves, which open by preffing on the keys, after the regifters are drawn, by which the air is prevented from going into any of the other pipes, befides thofe in which it is required.

SOUND-Board alfo denotes a thin broad board placed over the head of a public fpeaker, to enlarge or extend and ftrengthen his voice.

Sound-boards are found by experience to be of no ufe in theatres, as their diftance from the fpeaker is too great to be impreffed with fufficient force. But foundboards over a pulpit have frequently a good effect, when the cafe is conftructed of a proper thicknefs, and according to particular principles.

SOUND-Poft, is a poft placed in the infide of a violin, &c. as a prop between the back and belly of the inftrument, and nearly under the bridge.

SOUNDING, the operation of trying the depth of the fea, and the nature of the bottom, by means of a plummet funk from a fhip to the bottom.

There are two plummets ufed for this purpofe in navigation; one of which is called the *hand-lead*, weighing about 8 or 9 pounds; and the other the *deep fea-lead*, which weighs from 25 to 30 pounds; and both are fhaped like the fruftum of a cone or pyramid. The former is ufed in fhallow waters, and the latter at a great diftance from the fhore; particularly on approaching the land after a fea-voyage. Accordingly the lines employed for this purpofe are called the *deep-fea lead-line*, and the *hand lead-line*.

The hand lead-line, which is ufually 20 fathoms in length, is marked at every two or three fathoms; fo that the depth of the water may be afcertained either in the day or night. At the depth of two and three fathoms, there are marks of black leather; at 5 fathoms, there is a white rag; at 7, a red rag; at 10, black leather; at 13, black leather; at 15, a white rag; and at 17, a red ditto.

Sounding with the hand lead, which is called *heaving the lead* by feamen, is generally performed by a man who ftands in the main-chains to windward. Having the line quite ready to run out without interruption, he holds it nearly at the diftance of a fathom from the plummet; and having fwung the latter backwards and forwards three or four times, in order to acquire the greater velocity, he fwings it round his head, and thence as far forward as is neceffary; fo that, by the lead's finking whilft the fhip advances, the line may be almoft perpendicular when it reaches the bottom. The perfon founding then proclaims the depth of the water in a kind of fong refembling the cries of hawkers in a city. Thus if the mark of five fathoms is clofe to the furface of the water, he calls, 'By the mark five!" and as there is no mark at four, fix, eight, &c. he eftimates thofe numbers, and calls, 'By the dip four,' &c. If he judges it to be a quarter or an half more than any particular number, he calls, 'And a quarter five! and a half four,' &c. If he conceives the depth to be three quarters more than a particular number, he calls it a quarter lefs than the next: thus, at four fathoms and three fourths he calls 'A quarter lefs five!' and fo on.

The deep fea lead is marked with two knots at 20 fathoms, three at 30, four at 40, and fo on to the end. It is alfo marked with a fingle knot in the middle of each interval, as at 25, 35, 45 fathoms, &c. To ufe this lead more effectually at fea, or in deep water on the fea coaft, it is ufual previoufly to bring to the fhip, in order to retard her courfe: the lead is then thrown as far as poffible from the fhip on the line of her drift, fo that, as it finks, the fhip drives more perpendicularly over it. The pilot, feeling the lead ftrike the bottom, readily difcovers the depth of the water by the mark on the line neareft its furface. The bottom of the lead being alfo well rubbed over with tallow, retains the diftinguifhing marks of the bottom, as fhells, ooze, gravel, &c. which naturally adhere to it.

The depth of the water, and the nature of the ground, which is called the *foundings*, are carefully marked in the log-book, as well to determine the diftance of the place from the fhore, as to correct the obfervations of former pilots.

A machine for the fame purpofe has been invented by Mr Maffey, of which the following defcription is given:

"The importance of obtaining true foundings at fea muft be be admitted by every feaman ; and it is rather fingular, that no other method than the common lead has hitherto been brought into ufe ; as its imperfections are very generally acknowledged.

" Many veffels have been loft, by depending upon the foundings taken in the ufual way. The difficulty of obtaining the true perpendicular, and the uncertainty as to the exact moment when the lead ftrikes the bottom, upon which the accuracy of the refult depends, muft always prevent the poffibility of obtaining the true depth, while the fhip has any confiderable way upon her. Indeed, it has been acknowledged by experienced feamen, during fome experiments, made at various times, in the river Merfey, that they could not depend upon the common lead, when going five or fix knots in the hour, in ten or twelve fathoms of water. When the depth is confiderable, the veffel muft be hove to, which is an operation attended with great lofs of time, and fometimes confiderable injury to the fails ; and during a chafe, this inconvenience muft be particularly felt.

" True foundings may be taken with this machine in thirty fathoms water, without the trouble of heaving the veffel to, although fhe may be going at the rate of fix miles in the hour. True foundings may alfo thus be obtained in very deep water, where it is not poffible to take them by the common lead.

Plate ccccxcvii. Fig. 1.

" Fig. 1. reprefents the founding machine. *a* is the founding weight, containing a regifter, 1, 2, with two dials : the hand of the dial 1 makes one revolution when the weight has defcended twenty fathoms, the other revolves once when the defcent amounts to five hundred fathoms. A rotator, *b*, fimilar to that attached to the log, communicates with the wheel work of the dials 1, 2, by means of the rod *c*, on which there are three univerfal joints, 3, 4, and 5. This rod is fupported during the defcent of the weight, by the drop, *d*, at the end of which is a fork, 6, and a friction wheel, 7.

" When the machine is to be ufed, a founding line is faftened to the ring, *e* ; and one of the vanes of the rotator is flipped into the fpring 8 : the rotator will then be in the pofition indicated by the dotted lines, *x*. The indices muft be fet at 0, and the cover or lid, *f*, be fhut. The machine muft then be projected perpendicularly into the fea. As foon as it reaches the furface, the refiftance of the water forces the dotted rotator, *x*, out of the fpring 8, and it affumes its perpendicular direction as reprefented by the rotator *b*. As the machine defcends, it is evident the rotator will revolve, and its motion be communicated freely paft the friction wheel 7, and the univerfal joint 5, to the wheel work of the dials 1, 2, and thus indicate the fpace paffed through in fathoms. When the machine has arrived at the bottom, the rotator, as it is no longer buoyed up by the reaction of the water, will fall to the bottom, quitting the fork of the drop *d*, which will alfo fall from its horizontal pofition, and in its defcent, by means of the locking rod 9, prevent the rotator from revolving as the machine is drawn up. When at the bottom, the rotator will be in the pofition of the dotted lines *y*.

" This machine, fimple in its conftruction, and fcarcely more liable to accident than the common lead, afcertains, with the utmoft precifion, the perpendicular depth, by the mere act of defcent through the water. No miftake can arife from that common fource of errour, the drift or lee-way of the fhip during the time of defcent ; nor does an operation of fuch importance depend upon the uncertain fenfation caufed by the lead ftriking the bottom, on which the accuracy of the common log altogether depends, and which, it is well known, frequently and materially mifleads the beft feaman : for though a thoufand fathoms of line were paid out, in the fmalleft depth of water, no inaccuracy could arife, as the perpendicular depth, at the point of heaving, would be regiftered on the index. The only inconvenience experienced would be the additional labour neceffary for hauling in the excefs of line. The moft inexperienced perfon may ufe this machine, without rifk of error, in the moft turbulent fea, and during the night.

" The advantages already enumerated would render the founding machine of great importance ; but there are other properties of ftill more confequence.

" To heave a fhip to, in order to obtain foundings, on a lee fhore, in ftormy weather, is a very difagreeable operation, attended with much trouble, and lofs of way ; alfo with confiderable danger to the fhip's fails ; indeed, it would often, under fuch circumftances, be attended with great hazard to the fafety of the fhip. To avoid thefe unpleafant confequences, the mafter fometimes adopts a meafure, which he conceives to be the lefs exceptionable alternative, by running on without founding at all.

" To prove how much inconvenience and danger are avoided by Maffey's lead, it is enough to ftate, that foundings may be taken in depth from 60 to 80 fathoms, while the fhip is under way, at the rate of three miles an hour ; and as the rate of failing may be ftill materially reduced, without entirely ftopping the veffel, or altering her courfe, fo may foundings be had, to any depth required, while fhe is under way.

" In order more clearly to fhow the fuperiority of this machine, and make it apparent, that the quantity of ftray-line veered out does not at all affect the truth of the refult : fuppofe the common lead thrown from the mizen chains of the fhip, which may be reprefented by the point *a* of the triangle *a b c*, (fig. 2.), and that the fhip has moved forwards through the fpace equal to the line *b c*, while the lead has defcended through the line *a c* ; it is evident, that it is impoffible, in this cafe, to afcertain the exact depth, as a quantity of line, equal to *a b*, would be paid out, whereas the true depth is equal only to the line *a c*, which is much lefs. But the cafe is very different when the patent founding machine is ufed, as the operation ceafes when it has reached the bottom ; nor is the ftray-line, *a b*, whatever its length, at all taken into the account. Fig. 2.

" It has been extremely difficult, and fometimes impoffible, to obtain foundings in very deep water with the common lead, which may perhaps be thus accounted for. The common line which is ufed for founding, though, if left to itfelf, it would fink in water, yet its defcent would be much flower than that of the lead, feparately ; it confequently follows, that the lead muft be fo much impeded by carrying the line with it, that when it does reach the bottom, there will be fcarcely any fenfible check to enable the feaman to know the precife moment. Indeed, if he can afcertain even this to a certainty, he ftill cannot depend upon the truth of his foundings ; for if there be the leaft drift or current, the line itfelf will affume a curve, fimilar to that of the line of a kite in the air. Thefe two caufes will always operate

rate againſt the perfection of the common mode of ſounding.

" After ſo fully deſcribing the principle of the patent ſounding machine, it is ſcarcely neceſſary to prove, that is liable to neither of the foregoing objections; and it may be ſufficient to ſay, that, as it will certainly find its way to the bottom, if a ſufficient portion of ſtray-line be allowed to guard againſt its being checked in its progreſs, and the certainty of its having reached the bottom may be aſcertained by the arming, there can be no doubt of the practicability of its obtaining ſoundings, in any depth, and no reaſonable doubt of their correctneſs when obtained.

" From the conſtruction of this machine, it might be imagined, that the rotator would impede its motion through the water, and that it could not deſcend ſo rapidly as the common lead; but during repeated trials, in thirteen fathoms water, in which the rotator was frequently detached, and the lead ſuffered to deſcend alone, there was no difference perceptible in the time of their deſcent, though an excellent quarter-ſecond ſtop watch was uſed during the experiment, to detect any change. The following table ſhows how very uniformly the times of deſcent correſponded with the depths in fathoms, during a ſeries of trials made on the river Merſey, with the patent lead, weighing 14 pounds.

"The manner of conducting theſe experiments was ſuch as is deſerving of perfect reliance. Two pilots, of well-known ability and experience, were employed: one threw the lead, and the other, the moment he found, by the ſlackening of the rope, that the weight had arrived at the bottom, cried ' ſtop,' to a third perſon who held the watch.

Time of deſcent.	Fathoms.	Time of deſcent.	Fathoms.
2 ſeconds	$2\frac{1}{2}$	$7\frac{1}{2}$ ſeconds	$11\frac{1}{2}$
$2\frac{1}{2}$ ———	3	$7\frac{1}{4}$ ———	$11\frac{1}{2}$
3 ———	4	$7\frac{1}{4}$ ———	$11\frac{1}{2}$
5 ———	8	$7\frac{1}{2}$ ———	12
$5\frac{1}{4}$ ———	$8\frac{1}{2}$	$7\frac{3}{4}$ ———	$12\frac{3}{4}$
6 ———	10	8 ———	13
6 ———	10	$8\frac{1}{4}$ ———	$13\frac{1}{2}$
7 ———	$11\frac{1}{4}$	6 ———	10

" Taken when under ſail, at upwards of five knots in the hour.

" Several captains and maſters in the navy have made trial of the log and ſounding machine, and given very favourable reports of their performance; and it has been adopted by order of the Navy Board in the Britiſh navy *."

* Nicol. Journal, xxi. 250.

SOUP, a ſtrong decoction of fleſh or other ſubſtances.

Portable or dry ſoup is a kind of cake formed by boiling the gelatinous parts of animal ſubſtances till the watery parts are evaporated. This ſpecies of ſoup is chiefly uſed at ſea, and has been found of great advantage. The following receipt will ſhow how it is prepared.

Of calves feet take 4; leg of beef 12 lbs.; knuckle of veal 3 lbs; and leg of mutton 10 lbs. Theſe are to be boiled in a ſufficient quantity of water, and the ſcum taken off as uſual; after which the ſoup is to be ſeparated from the meat by ſtraining and preſſure. The meat is then to be boiled a ſecond time in other water; and the two decoctions, being added together, muſt be left to cool, in order that the fat may be exactly ſeparated. The ſoup muſt then be clarified with five or ſix whites of eggs, and a ſufficient quantity of common ſalt added. The liquor is then ſtrained through flannel, and evaporated on the water-bath to the conſiſtence of a very thick paſte; after which it is ſpread rather thin upon a ſmooth ſtone, then cut into cakes, and laſtly dried in a ſtove until it becomes brittle; theſe cakes are kept in well cloſed bottles. The ſame proceſs may be uſed to make a portable ſoup of the fleſh of poultry; and aromatic herbs may be uſed as a ſeaſoning, if thought proper.

Theſe tablets or cakes may be kept four or five years. When intended to be uſed, the quantity of half an ounce is put into a large glaſs of boiling water, which is to be covered, and ſet upon hot aſhes for a quarter of an hour, or until the whole is entirely diſſolved. It forms an excellent ſoup, and requires no addition but a ſmall quantity of ſalt.

SOUR-CROUTE. See CROUTE.

SOUR-Gourd, or *African Calabaſh-tree*. See ADANSONIA, BOTANY *Index*.

SOUTH, DR ROBERT, an eminent divine, was the ſon of Mr William South a merchant of London, and was born at Hackney near that city in 1633. He ſtudied at Weſtminſter ſchool, and afterwards in Chriſtchurch college, Oxford. In 1654, he wrote a copy of Latin verſes to congratulate Cromwell upon the peace concluded with the Dutch; and the next year a Latin poem, entitled *Muſica Incantans*. In 1660 he was elected public orator of the univerſity; and the next year became domeſtic chaplain to Edward earl of Clarendon, lord-high chancellor of England. In 1663 he was inſtalled prebendary of Weſtminſter, admitted to the degree of doctor of divinity, and had a ſinecure beſtowed on him in Wales by his patron the earl of Clarendon; after whoſe retirement into France in 1667 he became chaplain to the duke of York. In 1670 he was inſtalled canon of Chriſt church in Oxford; and in 1676 attended as chaplain to Laurence Hyde, Eſq. ambaſſador extraordinary to the king of Poland. In 1678 he was preſented to the rectory of Iſlip in Oxfordſhire; and in 1680 rebuilt the chancel of that church, as he afterwards did the rectory-houſe belonging to it. After the revolution he took the oath of allegiance to King William and Queen Mary, though he excuſed himſelf from accepting a great dignity in the church, vacated by the perſonal refuſal of that oath. His health began to decline ſeveral years before his death, which happened in 1716. He was interred in Weſtminſter Abbey, where a monument is erected to his memory. He publiſhed, 1. Animadverſions on Dr Sherlock's Vindication of the Holy and Ever Bleſſed Trinity. 2. A Defence of his Animadverſions. 3. Sermons, 8 vols 8vo. And after his deceaſe were publiſhed his *Opera Poſthuma Latina*, and his poſthumous Engliſh works. Dr South was remarkable for his wit, which abounds in all his writings, and particularly in his ſermons; but at the ſame time they equally abound in ill-humour, ſpleen, and ſatire. He was remarkable for being a time-ſerver. During the life of Cromwell he was a ſtaunch Preſbyterian, and then railed againſt the Independents: at the Reſtoration

tion he exerted his pulpit-eloquence againſt the Preſbyterians; and in the reign of Queen Anne, was a warm advocate for Sacheverel.

SOUTH, one of the four cardinal points from which the winds blow.

SOUTH Sea, or *Pacific Ocean*, is that vaſt body of water interpoſed between Aſia and America. It does not, however, ſtrictly ſpeaking, reach quite to the continent of Aſia, excepting to the northward of the peninſula of Malacca: for the water interpoſed between the eaſtern coaſt of Africa and the peninſula juſt mentioned has the name of the *Indian ocean*. The South ſea then is bounded on one ſide by the weſtern coaſt of America, through its whole extent, from the unknown regions in the north to the ſtraits of Magellan and Terra del Fuego, where it communicates with the ſouthern part of the Atlantic. On the other ſide, it is bounded by the coaſt of Aſia, from the northern promontory of Tſchukotſkoi Noſs, to the peninſula of Malacca already mentioned. Thence it is bounded to the ſouthward by the northern coaſts of Borneo, Celebes, Macaſſar, New Guinea, New Holland, and the other iſlands in that quarter, which divide it from the Indian ocean. Then, waſhing the eaſtern coaſt of the great iſland of New Holland, it communicates with that vaſt body of water encompaſſing the whole ſouthern part of the globe, and which has the general name of the *Southern ocean* all round. Thus does this vaſt ocean occupy almoſt the ſemicircumference of the globe, extending almoſt from one pole to the other, and about the equatorial parts extending almoſt 180° in longitude, or 12,500 of our miles.

The northern parts of the Pacific ocean are entirely deſtitute of land; not a ſingle iſland having yet been diſcovered in it from the latitude of 40° north and upwards, excepting ſuch as are very near the coaſt either of Aſia or America; but in the ſouthern part there are a great number.

Till very lately the South ſea was in a great meaſure unknown. From the great extent of ice which covers the ſouthern part of the globe, it was imagined that much more land exiſted there than in the northern regions: but that this could not be juſtly inferred merely from that circumſtance, is plain from what has been advanced under the article AMERICA, N° 3—24; and the ſouthern continent, long known by the name of *Terra Auſtralis*, has eluded the ſearch of the moſt expert navigators ſent out from Britain and France by royal authority. See TERRA AUSTRALIS.

SOUTH Sea Company. See COMPANY.

SOUTHAMPTON, a ſea-port town of Hampſhire in England. It is commodiouſly ſeated on an arm of the ſea; is a place of good trade, and well inhabited. It is ſurrounded by walls and ſeveral watch-towers, and had a ſtrong caſtle to defend the harbour, now in ruins. It is a corporation and a county of itſelf, with the title of an earldom, and ſends two members to parliament. W. Long. 1. 26. N. Lat. 50. 55.

SOUTHERN, THOMAS, an eminent dramatic writer, was born at Dublin in 1660, and received his education in the univerſity there. He came young to London to ſtudy law; but inſtead of that devoted himſelf to poetry and the writing of plays. His Perſian Prince, or Loyal Brother, was introduced in 1682, when the Tory intereſt was triumphant in England; and the character of the Loyal Brother being intended to compliment James duke of York, he rewarded the author when he came to the throne with a commiſſion in the army. On the Revolution taking place, he retired to his ſtudies, and wrote ſeveral plays, from which he is ſuppoſed to have derived a very handſome ſubſiſtence, being the firſt who raiſed the advantage of play-writing to a ſecond and third night. The moſt finiſhed of all his plays is Oroonoko, or the Royal Slave, which is built on a true ſtory related in one of Mrs Behn's novels. Mr Southern died in 1746, in the 86th year of his age; the latter part of which he ſpent in a peaceful ſerenity, having, by his commiſſion as a ſoldier, and the profits of his dramatic works, acquired a handſome fortune; and being an exact economiſt, he improved what fortune he gained to the beſt advantage. He enjoyed the longeſt life of all our poets; and died the richeſt of them, a very few excepted. His plays are printed in two vols 12mo.

SOUTHERN Continent. See AMERICA, N° 3—24, and *TERRA Auſtralis*.

SOUTHERNWOOD. See ARTEMISIA, BOTANY *Index*.

SOUTHWARK, a town of Surry, and a ſuburb of the city of London, being ſeparated from that metropolis only by the Thames. See LONDON, N° 96.

SOW. See SUS, MAMMALIA *Index*.

SOW, in the iron works, the name of the block or lump of metal they work at once in the iron furnace.

SOW-Thiſtle. See SONCHUS, BOTANY *Index*.

SOWING, in *Agriculture* and *Gardening*, the depoſiting any kind of ſeed in the earth for a future crop. See AGRICULTURE.

Drill-SOWING. See *DRILL-Sowing*.

SOY. See DOLICHOS.

SOZOMENUS, HERMIAS, an eccleſiaſtical hiſtorian of the 5th century, was born in Bethelia, a town of Paleſtine. He was educated for the law, and became a pleader at Conſtantinople. He wrote an Abridgment of Eccleſiaſtical Hiſtory, in two books, from the aſcenſion of our Saviour to the year 323. This compendium is loſt; but a continuation of it in nine books, written at greater length, down to the year 440, is ſtill extant. He ſeems to have copied Socrates, who wrote a hiſtory of the ſame period. The ſtyle of Sozomenus is perhaps more elegant; but in other reſpects he falls far ſhort of that writer, diſplaying throughout his whole book an amazing credulity and a ſuperſtitious attachment to monks and the monaſtic life. The beſt edition of Sozomenus is that of Robert Stephen in 1544. He has been tranſlated and publiſhed by Valeſius, and republiſhed with additional notes by Reading at London, 1720, in 3 vols folio.

SPA, a town of Germany, in the circle of Weſtphalia and biſhopric of Liege, famous for its mineral waters, lies in E. Long. 5. 50. N. Lat. 50. 30. about 21 miles ſouth-eaſt from Liege, and 7 ſouth-weſt from Lomburg. It is ſituated at one end of a deep valley on the banks of a ſmall rivulet, and is ſurrounded on all ſides by high mountains. The ſides of theſe mountains next to Spa are rude and uncultivated, preſenting a rugged appearance as if ſhattered by the convulſions of earthquakes; but as they are ſtrewed with tall oaks and abundance of ſhrubs, the country around forms a wild, romantic, and beautiful landſcape. The acceſs to the

Spa.

town is very beautiful. The road winds over the mountains till it defcends to their bottom, when it runs along a fmooth valley for a mile or a mile and a half.

The town confifts of four ftreets in form of a crofs, and contains about 400 inhabitants. Spa has no wealth to boaft of. It can fcarcely furnifh the neceffaries of life to its own inhabitants during the winter, and almoft all the luxuries which are requifite for the great concourfe of affluent vifitors during the fummer are carried from Liege by women. Its only fource of wealth is its mineral waters. No fooner does the warm feafon commence, than crowds of valetudinarians arrive, as well as many other perfons who are attracted folely by the love of amufement, and fome from lefs honourable motives. The inhabitants, who fpend feven or eight months of the year without feeing the face of a ftranger, wait for the return of this period with impatience. The welcome found of the carriages brings multitudes from the town, either to gratify their curiofity, or to offer their fervices in the hopes of fecuring your employment while you remain at Spa. Immediately after your arrival, your name and defignation is added to the printed lift of the annual vifitors; for which you pay a ftated fum to the bookfellers, who has a patent for this purpofe from the prince bifhop of Liege. This lift not only enables one to know at a glance whether any friends or acquaintance are refiding there, but alfo to diftinguifh perfons of rank and fafhion from adventurers, who feldom have the effrontery to infert their names.

There are two different ways of accommodating the vifitors at Spa with lodging and neceffaries. People may either lodge at a hotel, where every thing is furnifhed them in a fplendid and expenfive ftyle; or they may take up their refidence in private lodgings, from which they may fend for provifions to a cook's fhop.

Among the people who vifit Spa, there are many perfons of the firft rank and fafhion in Europe. Perhaps indeed there is no place in Europe to which fo many kings and princes refort; but it is alfo vifited by many felf-created nobility, who, under the titles of counts, barons, marquifes, and knights, contrive by their addrefs, and artifices, to prey upon the rich and unexperienced.

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The manners eftablifhed at Spa are conducive both to health and amufement. Every body rifes early in the morning, at fix o'clock or before it, when a great many horfes ftand ready faddled for thofe who choofe to drink the Sauveniere or Geronftere waters at a little diftance from Spa. After this healthy exercife a part of the company generally breakfaft together at Vauxhall, a magnificent and fpacious building. At this place a number of card-tables are opened every forenoon, round which many perfons affemble and play for ftakes to a very confiderable amount. A ball too is generally held once a week at Vauxhall, befides two balls at the affembly rooms near the Pouhon in the middle of the town.

The moft remarkable waters at Spa are, 1. The Pouhon, fituated in the middle of the town; 2. The Sauveniere, a mile and a half eaft from it; 3. Groifbeck, near to the Sauveniere; 4. Tonnelet, fituated a little to the left of the road which leads to the Sauveniere; 5. Geronftere, two miles fouth from Spa; 6. Wartroz, near to the Tonnelet; 7. Sarts or Nivefet, in the diftrict of Sarts; 8. Chevron or Bru, in the principality of Slavelot; 9. Couve; 10. Beverfe; 11. Sige; 12. Geremont. Thefe four laft are near Malmedy.

Dr Brownrigg was the firft perfon who difcovered that fixed air, or, as it is now generally called, *carbonic acid gas*, forms a principal ingredient in the compofition of the Spa waters, and actually feparated a quantity of this elaftic fluid, by expofing it to different degrees of heat from 110° to 170° of Fahrenheit. From 20 ounces 7 drams and 14 grains apothecaries weight of the Pouhon water, he obtained 8 ounces 2 drams and 50 grains. Since June 1765, when Dr Brownrigg read a paper on this fubject before the Royal Society of London, the waters of Spa have been often analyfed, but perhaps by none with more accuracy than by Dr Afh, who publifhed a book on the chemical and medicinal properties of thefe waters in 1788. We fhall prefent the refult of his analyfis of the five principal fprings in the following table.

Fountains.	Quantity of Water.	Ounce meafures of Gas.	Solid contents.	Aerated Lime.	Aerated Magnefia.	Aerated Mineral Alkali.	Aerated iron.	Selenite	Aerated Vegetab. Alkali.
	Ounces.		Grains.						
Pouhon	33.	35.75	16.25	2.75	9.50	2.25	1.75	—	—
Geronftere	32.75	24.75	5.50	2.50	—	1.75	0.75	0.50	—
Sauveniere	32.50	33.50	3.75	1.50	—	0.75	0.50	—	1.
Groifbeck	32.25	35.50	5.25	1.50	—	1.	0.75	—	2.
Tonnelet	32.	40.75	2.00	0.25	—	0.75	1.	—	—

The Pouhon fpring rifes from the hill to the north of Spa, which confifts of argillaceous fchiftus and ferruginous flate. The other fountains rife from the furrounding hills to the fouth eaft, fouth, weft, and northweft of the town; and this ridge of mountains is formed of calcareous earths mixed with filiceous fubftances. The furface of the mountains is covered with woods, interfperfed with large boggy fwamps filled with mud and water. The Pouhon is confidered as the principal fpring at Spa, being impregnated with a greater quantity of iron than any of the reft, and containing more fixed air than any except the Tonnelet. It is from this fpring that the Spa water for exportation is bottled; for which the demand is fo great, that, according to the beft information which Mr Thickneffe could obtain, the quantity exported amounts to 200,000 or 250,000 bottles annually. This exported water is inferior in its virtue to that which is drunk on the fpot; for the veffels into which it is collected are injudicioufly expofed to the fun, rain, wind, and duft, for feveral hours before they are corked, by which means a confiderable part of its volatile ingredients muft be evaporated; for it has been

Thickneffe's Journey through the Pais Bas.

been found by experiment, that by expofing it to a gentle heat, air-bubbles afcend in great numbers. It is in its greateft perfection when collected in cold dry weather; it is then pellucid, colourlefs, and without fmell, and almoft as light as diftilled water. It varies in its heat from 52° or 53° to 67° of Fahrenheit's thermometer.

The Geronftere is a much weaker chalybeate water than the Pouhon; and as it is exceedingly naufeous, and taftes and fmells like rotten eggs, it certainly contains fome hepatic gas. This is a circumftance which Dr Afh feems not to have attended to fufficiently. The Sauveniere water alfo, when newly taken from the well, fmells a little of fulphur. The Groifbeck contains more alkali, and almoft as much gas as the Pouhon, and has been celebrated for its good effects in the cafe of calculous concretions. The Tonnelet contains more gas than any of the reft. So fmall is the quantity of any foffil body held in fufpenfion by the aerial acid in it, and fo volatile is the gas, that it begins to pafs off very rapidly the moment it is taken out of the well, and in a fhort time is entirely gone. Dr Afh informs us, that in the neighbourhood of this well, the cellars, on any approaching change of weather, are found to contain much fixed air; and the beft prognoftic which they have of rain is the averfion which cats fhow to be carried into thefe cellars.

The Spa waters are diuretic, and fometimes purgative. They exhilarate the fpirits with an influence much more benign than wine or fpirituous liquors, and they are more cooling, and allay thirft more effectually than common water. They are found beneficial in cafes of weaknefs and relaxation, either partial or univerfal; in nervous diforders; in obftructions of the liver and fpleen; in cafes where the blood is too thin and putrefcent; in cafes of exceffive difcharges proceeding from weaknefs; in the gravel and ftone; and in moft cafes where a ftrengthening remedy is wanted. But they are hurtful in confirmed obftructions attended with fever, where there is no free outlet to the matter, as in ulcerations of the lungs. They are alfo injurious to bilious and plethoric conftitutions, when ufed before the body is cooled by proper evacuations.

SPACE. See METAPHYSICS, Part II. Chap. iv.

SPACE, in *Geometry*, denotes the area of any figure, or that which fills the interval or diftance between the lines that terminate it.

SPADIX, in *Botany*, anciently fignified the receptacle of the palms. It is now ufed to exprefs every flower-ftalk that is protruded out of a fpatha or fheath.

The fpadix of the palms is branched; that of all other plants fimple. This laft cafe admits of fome variety; in *calla*, *dracontium*, and *pothos*, the florets cover it on all fides; in *arum*, they are difpofed on the lower part only; and in *zoftera* on one fide. See BOTANY.

SPAGIRIC ART, a name given by old authors to that fpecies of chemiftry which works on metals, and is employed in the fearch of the philofopher's ftone.

SPAHIS, horfemen in the Ottoman army, chiefly raifed in Afia. The great ftrength of the grand feignior's army confifts in the janifaries, who are the foot; and the fpahis, who are the horfe.

1 Situation and boundary.

SPAIN. The kingdom of Spain, which occupies by far the greater portion of the fouth-weftern peninfula of Europe, is bounded on the north by the bay of Bifcay and Pyrenean mountains, which feparate it from France; on the eaft by the Mediterranean fea; on the fouth by the ftraits of Gibraltar, which divide it from the African kingdom of Morocco; and on the weft, partly by the Atlantic ocean, but chiefly by the narrow kingdom of Portugal. This laft is the only artificial boundary of the Spanifh territory, and confifts of ideal lines, except in three parts, where the river Minho to the north, and the Douro and the Chanca, till its junction with the Guadiana to the eaft, form rather more natural limits.

2 Extent.

From Cape Ortegal in N. Lat. 43° 44′, to the rock of Gibraltar, in N. Lat. 35° 57′, the continent of Spain extends through nearly 8° of latitude, while its extent from weft to eaft, viz. from Cape Finifterre in Long. 9° 17′ W. from Greenwich to Cape Creus, or Croix, in Long. 3° 30′ E. from the fame meridian, comprehends nearly 13° of longitude. In Britifh miles, its length from north to fouth, viz. from Cape Penas to Gibraltar, may be eftimated at 550 miles, while its medium breadth may be computed at 440. According to De Laborde, its fuperficial extent, exclufive of Portugal, is 25,137 fquare French leagues, or about 21,000 fquare Englifh leagues.

Befides the continental part of Spain, this monarchy comprehends feveral iflands in the Mediterranean, efpecially Majorca, Minorca, and Iviça; the Canary iflands, and feveral places on the north-weftern coaft of Africa; the Philippine and Ladrone iflands; together with an immenfe territory both in North and South America, comprehending Mexico, or New Spain, New Mexico, the ifland of Cuba, Porto Rico, &c. in North America, and in the fouthern part of that continent, the greateft portion of *Terra Firma*, Peru, Chili, almoft the whole of Paraguay, with an extenfive territory lying on the banks of the river Plate.

3 Divifion.

The ufual divifion of the Spanifh continent is into fourteen provinces, viz. thofe of CATALONIA, ARAGON, and NAVARRE, on the confines of France; BISCAY, ASTURIAS, and GALLICIA, on the fhores of the Atlantic; LEON and ESTREMADURA, on the fide of Portugal; ANDALUSIA chiefly on the ftraits of Gibraltar; GRANADA, MURCIA, and VALENCIA, on the fhores of the Mediterranean; OLD and NEW CASTILE in the centre.

The lateft writer on the geography of Spain, De Laborde, reckons only 13 provinces, as he includes Granada under Andalufia. In the following table we have brought together the moft important circumftances refpecting each of thefe provinces, viz. their fubdivifions, extent in fquare Britifh miles, population at the end of the 18th century, and chief towns; and we have arranged the provinces in the order followed by Laborde.


SPAIN
AND
PORTUGAL
BAY OF BISCAY
ATLANTIC OCEAN
MEDITERRANEAN
STRAIT OF GIBRALTAR
MAJORCA

Provinces.	Subdivisions.	Extent in square miles.	Population.	Chief Towns.
Province of CATALONIA.	County of Rouffillon ——— Cerdagne	10,400	814,412	BARCELONA, Tarragona, Urgel, Lerida, Gerona, Salfona, Vich, Tortofa, Figueras, &c.
Kingdom of VALENCIA.		7,800	932,150	VALENCIA, Alicant, Elche, Orihuela, Caftellan, Alzira, Carcaxente, Gandia, Xaciva, Otiniente, Alcoy, Segorbe, &c.
Province of ESTREMADURA.		16,000	416,922	BADAJOZ, Placencia, Coria, Merida, Truxillo, Xera de los Cavalleros, Llerina, Almatona, Zafra, &c.
Province of ANDALUSIA.	Kingdom of Seville	12,600	754,293	SEVILLE, Xeres de la Frontera, Arcos, Cadiz, Real Ejo, Ayamonte, Nivela, &c.
	——— Granada	4,500	661,661	GRANADA, Malaga, Loxa, Santa Fé, *Antiquera*, Ronda, Guadix, Baza, &c.
	——— Cordova	1,080	236,016	CORDOVA, and Archidona, &c.
	——— Jaen	2,400	177,136	JAEN, Ubeda, Baeza, Anduxar, &c.
Kingdom of MURCIA.		8,812	337,686	MURCIA, Carthagena, Lorca, Chinchilla, Alba Cete, Villena, Almanza, &c.
Kingdom of ARAGON.		16,500	623,308	ZARAGOZA, Iaca, Barbaftro, Huefca, Tarazona, Albarrazin, Teruel, &c.
Kingdom of NAVARRE.		2,287	287,382	PAMPELUNA, Tudela, &c.
Province of BISCAY.	Bifcay Proper	4,000	116,042	BILBOA, Vermijo, &c.
	Alava		74,000	VITTORIA, Trevino, Onate, &c.
	Guipuzcoa		12,076	ST SEBASTIAN, Fuenaraba, Tolofa, Placentia, &c.
Principality of the ASTURIAS.	Oviedo	3,375	350,000	OVIEDO, Aviles, Luarca, Gijon, &c.
	Santillana	1,200		SANTILLANA, San Vincente, Riva de Sella, &c.
Kingdom of GALLICIA.		11,500	1,350,000	SAN JAGO DE COMPOSTELLA, Bayona, Lugo, Orenfe, Mondonedo, Corunna, Vigo, &c.
Kingdom of LEON.	Leon Palencia Zamora Salamanca	10,750	665,432	LEON, Duero, Aftorga, Salamanca, Zamora, &c.
Kingdom of OLD CASTILE.	Burgos Avila Segovia	10,800	1,190,180	BURGOS, Ofma, Siguenza, Avila, Valladolid, Segovia, Calahorra, Soria, &c.
Kingdom of NEW CASTILE.	Toledo	22,000	1,146,809	MADRID, Toledo, Aranjuez, Talavera della Reyna, &c.
	Cuença			CUENÇA, Guete, Alacon, &c.
	Lamanca			OCANA, Hucles, Laguardia, Tarrazona, &c.
Kingdom of MAJORCA.	Iflands of Majorca	1,440	136,000	PALMA, Alcudia, &c.
	——— Cabrera			
	——— Iviça	110		IVIÇA.
Ifland of MINORCA.		360	27,000	MAHON, Cittadella.
			10,308,505	

Some account of thefe provinces will be found under the articles ANDALUSIA, ARAGON, ASTURIAS, BISCAY, CASTILE, CATALONIA, ESTREMADURA, GALLICIA, GRANADA, LEON, MURCIA, NAVARRE, VALENCIA, IVICA, MAJORCA and MINORCA; but, for the beft view of their prefent ftate, we muft refer our readers to De Laborde's *View of Spain*, vols i. ii. and iii. or to Playfair's *Geography*, vol. i.

In its general appearance, Spain prefents a pleafing variety of hill and dale, mountain and valley. It muft be regarded as a mountainous country, its plains being few in number and of fmall extent. The moft remarkable of thefe occupies the centre of the kingdom, efpecially New Caftile, which forms the moft elevated tract of level country to be found in Europe, having a mean elevation of more than 300 fathoms above the level of the fea. The country is well wooded, and abounds with rivers; but thefe are often very deficient in water, and

4 Face of the country.

Spain, eſpecially on its eaſtern coaſt, is remarkable for the dryneſs of its ſoil. Notwithſtanding this aridity, however, moſt parts of the kingdom teem with fertility, and native verdure and high cultivation render the ſcenery delightful. Here and there, indeed, occurs a tract of deſert utterly incapable of cultivation; but, in general, nature has done much more for the country than the labour of its inhabitants.

5 Soil. The ſoil is ſaid to be in general light, and eaſily wrought; but on many parts of the eaſtern coaſt it is compoſed chiefly of a ſtiff loam or clay. The moſt fertile parts of the kingdom are in Valencia, on the coaſt of Granada, in the kingdom of Old Caſtile, and in ſeveral parts of thoſe of New Caſtile and Leon. The ſoil of Catalonia is very diſcouraging, except in the valleys, and the ſame may be ſaid of all the provinces bordering on the Pyrenees; the ſoil of Eſtremadura, though naturally good, has been ſo long abandoned to itſelf, that it has almoſt ceaſed to produce, and that of Andaluſia has a very mixed character. The ſoil of Murcia is uncommonly arid; that of the Aſturias cold; that of Gallicia extremely wet. In the neighbourhood of Carthagena there is an extenſive tract, which is ſo covered with ſtones as to form a deſert as ſterile and untameable as any on the ſandy plains of Africa or Arabia.

6 Mountains. We have ſaid that Spain is a mountainous country. The chain of the Pyrenees, common to it and France, is by no means the moſt conſiderable in point either of elevation or extent; though that chain may be regarded as the common root or origin of all the reſt. From the weſtern corner of the Pyrenees a vaſt ridge branches off through Navarre, Biſcay, Aſturias, and Gallicia, terminating only at Cape Finiſterre, and Cape Ortegal. This ridge is the *Cantabrian* mountains, and is diſtinguiſhed into ſeveral ſubordinate groups, denominated from the principal towns ſituated in their vicinity. Thus we have the mountains of Mondonedo in Gallicia. In general, theſe groups are called *Sierras*, from the jagged or *ſerrated* appearance of their tops; as the *Sierra de la Aſturias*, *Sierra d'Avila*, &c. The ſubordinate mountains that extend from the Sierra of the Aſturias in the north, to the Alpuxaras in the ſouth, run in parallel lines; and the ſame direction prevails in the mountains of Saint Andero, which join the Pyrenees.

From the mountains of Biſcay ariſes a main ridge, which, after proceeding a little to the ſouth, divides into three or four branches. Of theſe the moſt northerly chain ſeparates the provinces of Old Caſtile and New Caſtile, extending to the confines of Portugal, and called the mountains of Guadarrama. A ſecond branch divides the principal part of New Caſtile from the province of La Mancha, running from the north-eaſt to the ſouth-weſt, as far as Badajos in Eſtremadura. The moſt remarkable part of this chain is the Sierra of Guadalupe. South of theſe runs the Sierra Morena, or Sable mountains, rendered claſſical by the inimitable pen of Cervantes. This is the laſt chain till we reach the Alpuxaras, that extend through the provinces of Granada and Andaluſia.

Of theſe mountains there are two points, which, in elevation, exceed Mont Perdu, the higheſt of the Pyrenees, viz. the Pico de Venleta, in the Sierra Nevada, or ſnowy mountains of Granada, which is elevated more than 1781 fathoms above the level of the ocean, and the peak of Mulahaſen, in the ſame chain, raiſed above 1824 fathoms, which is within 76 fathoms of the peak of Teneriffe.

7 Capes and promontories. The principal capes and promontories of the Spaniſh continent are, Cape Creus, Cape St Antoine, oppoſite the iſland of Iviça; Cape Palas, near Carthagena; Cape de Gatte, near Almeria, and the promontory on which ſtands the town of Gibraltar, all on the coaſt of the Mediterranean; and Cape Machicaco, Cape Penas, Cape Ortegal, the promontory of Ferrol, Cape Finiſterre, and Cape Trafalgar, on the coaſts of the Atlantic.

8 Bays and gulfs. The principal bays and gulfs on the coaſt of Spain, purſuing the ſame courſe, are the following; the bay of Valencia, the bay of Alicant, the gulf of Carthagena, the bay of Almeria, the bay of Gibraltar, the harbour of Cadiz, the bay of Corunna, commonly called the Groyne, and the bay of Biſcay.

9 Rivers. The rivers of Spain are intimately connected with the mountains from which they derive their ſource, and between the chains of which they generally flow. The moſt important are, the Ebro, riſing in the mountains of Santillana in the Aſturias, and running in a ſouth-eaſtern direction between the Caſtiles and Valencia on the one hand, and the provinces of Navarre, Aragon, and Catalonia, on the other, till it reaches the Mediterranean, at a ſmall diſtance from Tortoſa; the Xacar, riſing in the Sierra of Cuença in New Caſtile, and flowing into the Mediterranean conſiderably to the ſouthward of Valencia; the Segura, riſing in a mountain of the ſame name, traverſing the province of Murcia, and meeting the Mediterranean about midway in the capital of that province, and Alicant. Theſe flow into the Mediterranean, and there are ſeveral other rivers of leſs note, which pour their waters into the ſame ſea, and which we can merely enumerate. Theſe are the Ter at Gerona, the Lobregate at Barcelona, and the Mijares, paſſing by Segorbe. The rivers which flow into the Atlantic are, the Guadalquiver, riſing at the foot of Mount Segura, from the oppoſite ſide of which originates the river of the ſame name, flowing with a ſluggiſh courſe through the province of Andaluſia, and meeting the Atlantic a little to the north-weſt of Xeres; the Guadiana, riſing among ſome lakes to the north-weſt of Alcaraz in New Caſtile, and paſſing between the Sierra Morena and the Sierra de Guadalupe, till, near Badajos, it enters the kingdom of Portugal, and runs nearly in a ſoutherly direction, till it meets the Atlantic at Ayamonte; the Tagus, riſing among the mountains of Albaraçin in New Caſtile, and running weſterly till, at Alcantara, it becomes a river of Portugal; the Douro, riſing in Old Caſtile near Soria, and paſſing by Valladolid and Zamora, near which it forms a part of the boundary of Portugal; the Minho, riſing in the mountains of Gallicia, and running to the ſouth-weſt, till it meets the Atlantic to the north of Camina. The only other river of any importance in this direction is the Lima, ſuppoſed to be the Lethe of the poets, which riſes in Gallicia, and flows into the ſea below Viara.

10 Lakes. If we except the ſeries of ſmall lakes from which we have ſaid the river Guadiana takes its riſe, there are, in Spain, few lakes that merit particular notice. The moſt remarkable of theſe is the lake of Abulfera, in the province of Valencia. This lake begins near the village of Catarroija, about a league ſouth of the city of Valencia, and extends nearly four leagues as far as Cullera. When it

Spain. it is full, it is about four leagues long, two in breadth, and fix in circumference; but it is fo fhallow, that fmall boats can fcarcely float in it. To fupply the deficiency of water, an engine is employed, by which the neighbouring waters are drawn into the bed of the lake; and any fuperabundant water occafioned by heavy rains, is carried off into the fea by means of an artificial opening. This lake contains a great many fifh, and numerous aquatic birds make it their haunt. On certain days in the year the inhabitants of Valencia make incurfions hither to fhoot the birds, and the furface of the lake is at thefe times covered with boats.

11 Forefts. Many parts of the kingdom of Spain abound in large tracts of wood. Extenfive forefts are found in Catalonia, the Afturias, Gallicia, and in the Sierra Morena. It is in the mountainous chains that the forefts of Spain are moft remarkable; and there are few of thefe heights, except in the fnowy regions of the Sierra Nevada, but what are covered with wood almoft to their fummits.

12 Climates and feafons. The climate of Spain is as delightful as that of any part of Europe; and though at certain feafons of the year the eaftern coaft is fubject to exceffive heat and drought, and the north-weftern to almoft perpetual rains, the temperature is in general mild, and the air falubrious.

The climate of Spain has been admirably depicted by M. A. de Humboldt; and we fhall here prefent to our readers the fubftance of his remarks, as they are related by De Laborde, in his view of Spain.

No country of Europe prefents a configuration fo fingular as Spain. It is this extraordinary form which accounts for the drynefs of the foil in the interior of the Caftiles, for the power of evaporation, the want of rivers, and that difference of temperature which is obfervable between Madrid and Naples, two towns fituated under the fame degree of latitude.

The interior of Spain is, as we have feen, an elevated plane, which is higher than any of the fame kind in Europe, occupying fo large an extent of country. The mean height of the barometer at Madrid is 26 inches $2\frac{2}{3}$ lines. It is therefore $\frac{1}{11}$ lower than the mean height of the mercury at the level of the ocean. This is the difference of the preffure of the atmofphere that is experienced by all bodies expofed to the air at Madrid, and at Cadiz and Bourdeaux. At Madrid the barometer falls as low as 25 inches 6 lines, and fometimes even lower.

The following is a table of the variations in the height of the barometer during the firft nine months of the year 1793.

Months.	Maximum.		Minimum.		Mean Height of the Mercury	
1793.	Inches.	Lines.	Inches.	Lines	Inches.	Lines
January,	26	5.8	25	9.8	26	2.6
February,	26	5.3	25	6.2	26	1.6
March,	26	4.7	25	6.	25	11.6
April,	26	2.4	25	6.9	25	11.6
May,	26	4.6	25	10.5	26	0.8
June,	26	4.	25	11.8	26	1.6
July,	26	4.3	26	0.7	26	2.4
Auguft,	26	3.2	25	11.5	26	1.4
September,	26	4.3	25	11.	26	1.7

From the mean height of the barometer at Madrid, we find that capital to be elevated $309\frac{6}{10}$ fathoms above the level of the ocean. Madrid, confequently, ftands as high as the town of Infpruck, fituated in one of the higheft defiles of the Tyrol, while its elevation is 15 times greater than that of Paris, and three times greater than that of Geneva.

According to M. Thalacker, the mineralogift, who has taken feveral heights with the barometer in the environs of Madrid, the elevation of the king's palace at San Ildefonfo is 593 fathoms, which is higher than the edge of the crater of Mount Vefuvius, and is, ftrictly fpeaking, in the regions of the clouds, which generally float from 550 to 600 fathoms high.

The height of the plain of the Caftiles has an evident effect on its temperature. We are aftonifhed at not finding oranges in the open air under the fame latitude as that of Tarentum, part of Calabria, Theffaly, and Afia Minor; but the mean temperature of Madrid is very little fuperior to that of Marfeilles, Paris, and Berlin, and is nearly the fame with that of Genoa and Rome. The following table fhews the mean temperature at Madrid and at Rome, during the firft nine months of the years 1793 and 1807.

	At Madrid.			At Rome.		
Months	Deg. of Fahrenheit.			Deg. of Fahrenheit.		
January,	39°	3		40°	11′	15″
February,	43	24		47	49	30
March,	47	54		50	15	45
April,	52	19	30″	54	34	30
May,	59	4	30	65	56	15
June,	72	32	15	72	30	
July,	77	13	30	79	15	
Auguft,	81	34	30	79	15	
September,	65	45		72	34	30

Thus, the mean temperature at Madrid appears to be 59° of Fahrenheit, while that of the coafts of Spain, from the 41° to the 36° of Lat. is between $63\frac{3}{4}$° and 68° of Fahrenheit. In the former climate we find that orange trees will not flourifh in perfection, while in the latter we fee banana trees, heliconias, and even fugar-canes, growing in fituations that are fheltered from the cold winds.

13 Animals. Spain prefents few fpecies of animals that are not found in the other parts of fouthern Europe. Among the quadrupeds, we may remark, as peculiar to Spain, the genet, *(viverra genetta)*. The bear is found in feveral parts of the great Pyrenean chain, efpecially on fome of the mountains of Aragon, as well as thofe of Oecar and Reynofa in Old Caftile. Wolves are met with in all the higher and mountainous parts of the country, and wild boars on the mountains of Navarre, on the Pinar, and the Sierra de Carafcoy, in the kingdom of Valencia. The roebuck is found on fome of the mountains of Navarre, and the lynx and the ibex on thofe of Cuença in New Caftile, in the valleys of Aure and Giftau, as well as in the Pyrenees. The glory of Spanifh zoology is the horfe, for which this kingdom has been famous in all ages. The Spanifh horfes

Spain.

horses have probably originated from the Barbs of the north of Africa, supposed to be the immediate offspring of the Arabian breed. The Spanish mules are also excellent, and the ass is here no ignoble animal, though not equal to those of Arabia. There is little remarkable in the breed of cattle, but the Merino sheep have long been distinguished, and are perhaps superior to any in the world for the beauty of the fleece, if not for the delicacy of the mutton. The flocks of Merino sheep are sometimes extremely large, and Mr Townsend mentions one nobleman who possessed not fewer than 40,000. The whole number in the kingdom may be estimated at about 5,000,000. These animals were, by a special code, called the *Mesta*, authorised to travel from one province to another, according as the season presented the best pasturage in the mountains or the plains. The fleece of the Merino sheep is esteemed double in value to that of any other breed.

Of the birds more peculiarly found in Spain, the *vulture*, *percnopterus*, the *cuculus glandarius*, *cuculus tridactyla*, *motacilla hispanica*, *hirundo mellia*, and *hirundo rupestris*, are the most remarkable.

Fresh-water fishes are very plentiful in the Spanish rivers; but those in most esteem are from the small river Tormes in Old Castile, where have been taken trout of 20 lbs. weight. The tench of the lakes near Tobar in New Castile, are remarkably fine and delicate, and are taken in great abundance every year, during the months of May and June. The fish taken on the coasts are much the same as those of the other countries bordering on the Mediterranean and the Atlantic. The tunny was formerly taken on the eastern coast, where it formed a particular branch of the fishery, but is now, we believe, little regarded.

Among the Spanish insects, the most remarkable are, the cantharides, (*meloë vesicatorius*), and the kermes insect (*coccus ilicis*). The latter insect is much cultivated as an article of dyeing, especially in the territory of Bujalance, and of Fernan Nunes in the kingdom of Cordova, as also in the vicinity of the town of De las Aguas, four leagues from Alicant, and near the river Henares, in New Castile. The evergreen oaks on which these animals feed, present in the spring, a most singular appearance, from the red *nidi* of the kermes, with which their leaves are covered.

14 Vegetables.

No country of Europe of the same extent, furnishes such an ample field for the researches of the botanist, as Spain; and indeed its botany constitutes a very important part of its natural history. The mountainous districts are clothed with the ever-green oak, the common oak, the chesnut, and in some places various species of pine; but their most useful production is the cork tree. The smaller heights produce the wild olive, the almond, the shumac, the laurel, the bay, the cypress, Canary and Portugal broom, the yellow jessamine, and the Provence rose. The vine, the palm tree, the orange, the lemon and the olive, are so nearly naturalized as to require but little cultivation; and the same may be said of the kali (*salsola soda*), which is produced in large quantities on the coasts, and furnishes the best kind of kelp, commonly called *barilla*, used in the manufacture of soap and glass. The plains and valleys are covered with many of those plants which form some of the greatest ornaments of our flower gardens, as the tulip, several species of iris, the pæony, the passion flower, the orange and martagon lily, the jonquil, several species of narcissus and hyacinth, and above all the rhododendron. The mountains, however, exhibit the greatest variety of botanical riches. Those most worthy of the visits and researches of the enterprising botanist, are, the Sierra de Guadalupe in Estremadura; the mountains of Moncayo in Aragon; of Pineda, Guadarrama, and Cuença, in New Castile; of Caroscoy, in the kingdom of Murcia; of Pena-Colosa, Mongi, Aytona, and Mariola, in the kingdom of Valencia, and the Pyrenees.

The sugar-cane, was, before the discovery of the West India islands, one of the most important objects of Spanish cultivation, and numerous sugar mills were established along the coast of the Mediterranean, especially in the kingdom of Granada. At the conquest of that Moorish kingdom, not fewer than fourteen sugar plantations and two mills, were found within the province. Some sugar canes are still cultivated in the kingdom of Valencia, but the manufacture of sugar is discontinued, and the canes are used only for distillation. There is, we believe, still a manufactory for sugar from Spanish canes in Granada.

15 Minerals.

Spain has long been celebrated for the riches of its mineral kingdom, and it may still be considered as the Mexico and Peru of Europe. There are few metals which may not be found in this kingdom; and, till the discovery of America put the Spaniards in possession of mines which far surpass their own in produce, the gold and silver mines of Spain were thought to be nearly the richest in the world. At present, no gold mines are wrought, but grains of that metal are found disseminated in ferruginous quartz, forming a vein that passes through a mountain near the village of San Ildefonso in Old Castile. Spangles of gold are found intermixed with emery, in a mine near Alocer in Estremadura, and in the territory of Molena in Aragon; and this metal is occasionally found in the sand of two rivers; the Agneda, in the kingdom of Leon, which rises from the mountains of Xalamo, and the Tagus in New Castile, especially in the vicinity of Toledo.

Silver is much more abundant, but most of its mines have also been abandoned. We believe the only silver mine now in work is that of the Sierra de Guadalupe, near the village of Logrozen, where the silver is found mixed with micaceous schistus. The most remarkable silver mines formerly worked are those of Alrodoval del Campo; of Zalamea on the road to Alocer in Estremadura; of Almazaron near Carthagena; three in the Sierra Morena, about a league from Guadalcanal, in the kingdom of Seville, and another about two leagues from Linarez, in the kingdom of Jaen. This last mine was well known both to the Carthaginians and the Romans; while Spain was under the dominion of the former it belonged to Himilca, the wife of Asdrubal. After having been long abandoned, it was again wrought in the 17th century, when a vein of ore five feet in diameter was discovered; at present, however, it is no longer in a state of activity.

Mines of copper are found near Pampeluna in Navarre, near Salva Tierra in Alava; near Escarray, and at the foot of the mountains of Guadarama in Old Castile; near Lorea in Murcia; near the Chartreuse of the Val de Christo in Valencia; in the Sierra de Guadalupe in Estremadura; in the mountains near Cordova; near Riotinto, and at la Canada de los Conejos in Seville; in

Spain. in the diſtrict of Albuladui in Granada, and near Lenarez in the kingdom of Jaen.

There are numerous lead mines, eſpecially near Tortoſa in Catalonia; at Zoma, Benaſques, and Plan in Aragon; near Logroſen and Alcoſer in Eſtremadura; in the mountain Guadarrama in Old Caſtile; near los Alumbres and Lorca in Murcia; at Alcaniz and Conſtantina in Seville, and at the diſtrict of Linarez in Jaen.

The mines of iron are abundant, and need not be enumerated. Of antimony there are two mines, both in the diſtrict of La Mancha. One of theſe is at Alendia, near Almodovar; the other at the foot of the Sierra Morena. There is only one mine of cobalt, viz. in the province of Aragon, found in the valley of Geſton. There are two mines of cinnabar in Valencia; one about two leagues from Alicant in the limeſtone mountains of Alcoray; the other between Valencia and San Felipe; and two others in the ſame province, that produce native mercury, but none of theſe are worked. The moſt abundant mine of mercury and cinnabar united is in the diſtrict of La Mancha, on the borders of Cordova. It is ſituated in a hill of ſandſtone which reſts on ſlate. The whole length of the hill is traverſed by two principal veins, both of which were wrought by the Romans. The whole of this mine was lately wrought by the agents of the king, and its produce was very abundant.

Plumbago is found in a thick vein intermixed with feldſpar, about a league from the village of Real Monaſterio, in the kingdom of Seville. Mines of ſulphur occur, both in Aragon and Murcia; jet has been found in the diſtrict of Old Colmenar, in Old Caſtile; and there is good evidence of the preſence of coal at ſeveral places in Catalonia, in the Aſturias, New Caſtile, and Aragon; but it is ſaid that no coal mines have as yet been opened.

The marbles of Spain are very numerous and valuable. A black marble, veined with white, is procured near Barcelona; many dendritic marbles occur near Tortoſa. Near the town of Molina, in Aragon, is found a granular marble ſpotted with red, yellow, and white. At the village of Salinos, in the diſtrict of Guipuzcoa, is a beautiful blue pyritical marble, containing marine ſhells. From Monte Sagarra, near Segorbia, in the province of Valencia, are procured ſeveral fine marbles, which were held in great eſtimation even by the Romans. The province of Granada, however, contains more valuable varieties of this beautiful mineral than all the reſt of Spain; of theſe ſome of the principal are the following. A pure white ſtatuary marble, of which the whole mountain of Filabra, near Almeria, is compoſed; a fleſh-coloured marble from a mountain near Antiquera; an exquiſitely beautiful wax-coloured alabaſter, from the vicinity of the city of Granada; and a finely veined marble from the Sierra Nevada.

16 Mineral waters.

Of the Spaniſh mineral waters the following are the moſt celebrated. The principal cold ſprings are, a hepatic water in the town of Buron, in Valencia; a carbonated water at Gerona, in Catalonia; a ſaline purgative water at Vacia-Madrid, three leagues from the capital, and another of a ſimilar nature near Toledo.

The principal hot ſprings are, the baths of Abu-Zulena, at Javal-Cohol, near Bæza; a hepatic ſpring uſed for bathing near Alhama de Granada; another near Almeria, in the province of Granada, to which are attached both bathing and vapour baths: all theſe were diſcovered, or at leaſt brought into general uſe, by the Moors. A very copious hot ſpring near Merida, in Eſtremadura, made uſe of by the Romans. The Calda de Bonar, in the neighbourhood of Leon, a ſpring of tepid water frequented by the Romans, and ſtill exhibiting the ruins of baths and ancient inſcriptions. A very hot ſpring near Orenſe, in Gallicia. A ſpring at Alhama, near Calatayud, in Aragon, formerly much frequented, but now in a ſtate of neglect. The Fuente de Buzot, near Alicant, a ſaline ſpring of the temperature of 104° Fahrenheit. A very copious and hot ſpring at Archena, near Murcia, where ſtill remain the ruins of Roman and Mooriſh baths. A hepatic ſpring near Arnedillo, in Old Caſtile. 17

Natural curioſities.

Among the natural curioſities of Spain, we may particularize the mountain of Montſerrat in Catalonia (ſee MONTSERRAT); the inſulated hill of rock ſalt near the town of Cardona, in Catalonia (ſee GEOLOGY, N° 102.); the ſubterranean lake contained within a cavern in the neighbourhood of the Cava Perella, in the iſland of Minorca; the ſtalactitic cave called St Michael's, on the weſt ſide of the rock of Gibraltar, and the river Guadiana, which appears and diſappears ſeveral times in the courſe of its progreſs to the ſea. 18

Spaniſh iſlands.

The various groups of iſlands that are ſubject to Spain have long been diſtinguiſhed by particular names. Thus *Majorca*, *Minorca*, *Cabrera* and *Dragonera*, were called by the ancients *Inſulæ Baleares*, and are ſtill named the *Balearic Iſles*; while Iviça and *Feromentara* form a leſſer group, denominated the *Pityuſe Iſles*. Of theſe iſlands, the latter were taken poſſeſſion of by the Carthaginians nearly 700 years before the Chriſtian era; and about 200 years after that enterpriſing people made themſelves maſters of the Balearic iſles. After the fall of Carthage, all theſe iſlands long maintained a ſtate of piratical independence, and only Majorca was ever completely ſubject to the Romans. In the time of Auguſtus we are told that the Balearic iſles were ſo infeſted with rabbits, that the inhabitants ſent deputies to Rome for aſſiſtance to deſtroy theſe formidable invaders of their plantations. In the year 426 of the Chriſtian era, theſe iſlands came into the poſſeſſion of the Vandals, from whom they were taken at the end of the 8th century by the African Moors. At the beginning of the 9th century they were ſeized on by a fleet ſent into the Mediterranean by Charlemagne; but they were ſoon after reconquered by the Moors, who maintained the ſovereignty in theſe iſlands till, in 1228, they were finally diſpoſſeſſed by Don James grandſon of Alphonſo II. king of Aragon. 19

Names of Spain.

Though Spain appears to have been known to the Phœnicians nearly 1000 years before the birth of Chriſt, it ſeems to have been little regarded by the Greeks till after the period when Herodotus compoſed his hiſtory. Some part of this country was probably the Tarſhiſh of Scripture, from which the Phœnicians imported gold, ſilver, and other precious commodities into Judea. When the Greeks had eſtabliſhed a colony at Marſeilles, they muſt have been well acquainted with at leaſt the northern part of this peninſula, to which they gave the names of Iberia and Celtiberia, from two nations who then inhabited the country, and of Heſperia, from its extreme ſituation in the weſt of the then known world. The name Hiſpania, from which its modern appellation

Spain. is derived, was beftowed on it by the Romans; but the etymology of this name is uncertain.

20 Original population. The Aborigines of Spain were doubtlefs a Celtic tribe, which probably paffed into this peninfula from the adjoining continent of Gaul, though at a very early period they appear to have been mixed with a colony of Mauritani, or Moors from the coaft of Africa. The Celtic inhabitants, or Celtiberi, feem to have poffeffed the north-eaft of the peninfula, while the Mauritani occupied the fouthern and fouth-weftern diftricts.

21 Spain invaded by the Carthaginians. An. 240. B. C. Nothing certain is known refpecting the early ftate of Spain, till the commencement of the firft Punic war between the Romans and the Carthaginians, in the middle of the third century before Chrift. Not long before this date, probably at the beginning of the century, the latter people had poffeffed themfelves of Catalonia, when their general Hamilcar Barcas is faid to have founded the city of Barceno, the modern Barcelona. The Carthaginian colony, however, feems to have been rather a mercantile than a warlike fettlement, and the Celtiberi were more the allies than the fubjects of their African neighbours. Of the contefts carried on between the Carthaginians and the Romans, till the final fubjugation of the former, and the confequent occupation of all their territories by the Roman republic, we have given an account under the articles CARTHAGE and ROME. We fhall here briefly confider the ftate of Spain at the time of its occupation by the Romans, and relate the events to which that occupation gave rife, and which are lefs connected with the more immediate tranfactions of the Punic wars.

22 State of Spain at the Roman conqueft. At the time of the Roman conqueft, Spain, though prodigious quantities of filver had been carried out of it by the Carthaginians and Tyrians, was yet a very rich country. In the moft ancient times, indeed, its riches are faid to have exceeded what is related of the moft wealthy country in America. Ariftotle affures us, that when the Phenicians firft arrived in Spain, they exchanged their naval commodities for fuch immenfe quantities of filver, that their fhips could neither contain nor fuftain its load, though they ufed it for ballaft, and made their anchors and other implements of filver. When the Carthaginians firft came to Spain, they found the quantity of filver nothing leffened, fince the inhabitants at that time made all their utenfils, and even mangers, of that precious metal. In the time of the Romans this amazing plenty was very much diminifhed; however, their gleanings were by no means defpicable, fince in the fpace of nine years they carried off 111,542 pounds of filver, and 4095 of gold, befides an immenfe quantity of coin and other things of value (A). The Spaniards were always remarkable for their bravery, and fome of Hannibal's beft troops were brought from thence; but as the Romans penetrated farther into the country than the Carthaginians had done, they met with nations whofe love of liberty was equal to their valour, and whom the whole ftrength of their empire was fcarcely able to fubdue. Of thefe the moft formidable were the Numantines, Cantabrians, and Afturians.

23 Succeffes of Viriathus againft the Romans. In the time of the third Punic war, one Viriathus, a celebrated hunter, and afterwards the captain of a gang of banditti, took upon him the command of fome nations who had been in alliance with Carthage, and ventured to oppofe the Roman power in that part of Spain called *Lufitania*, now Portugal. The prætor, named *Vetilius*, who commanded in thofe parts, marched againft him with 10,000 men; but was defeated and killed, with the lofs of 4000 of his troops. The Romans immediately difpatched another prætor with 10,000 foot and 1300 horfe: but Viriathus having firft cut off a detachment of 4000 of them, engaged the reft in a pitched battle; and having entirely defeated them, reduced great part of the country. Another prætor, who was fent with a new army, met with the fame fate; fo that, after the deftruction of Carthage, the Romans thought proper to fend a conful named *Quintus Fabius*, who defeated the Lufitanians in feveral battles, and regained two important places which had long been in the hands of the rebels. After the expiration of Fabius's confulate, Viriathus continued the war with his ufual fuccefs, till the fenate thought proper to fend againft him the conful Q. Cæcilius Metellus, an officer of great valour and experience. With him Viriathus did not choofe to venture a pitched battle, but contented himfelf with acting on the defenfive; in confequence of which the Romans recovered a great many cities, and the whole of Tarraconian Spain was obliged to fubmit to their yoke. The other conful, named *Servilianus*, did not meet with the fame fuccefs; his army was defeated in the field, and his camp was nearly taken by Viriathus. Notwithftanding the good fortune of Metellus, however, he could not withftand the intrigues of his countrymen againft him, and he was not allowed to finifh the war he had begun with fo much fuccefs. In refentment for this he took all imaginable pains to weaken the army under his command: he difbanded the flower of his troops, exhaufted the magazines, let the elephants die, broke in pieces the arrows which had been provided for the Cretan archers, and threw them into a river. Yet, after all, the army which he gave up to his fucceffor Q. Pompeius, confifting of 30,000 foot and 2000 horfe, was fufficient to have crufhed Viriathus if the general had known how to ufe it. But, inftead of oppofing Viriathus with fuccefs, the imprudent conful procured much more formidable enemies. The Termantians and Numantines, who had hitherto kept themfelves independent, offered very advantageous terms of peace and alliance with Rome; but Pompeius infifted on their delivering up their arms. Upon this war was immediately commenced. The conful with great confidence invefted Numantia; but being repulfed with confiderable lofs, he fat down before Termantia, where he was attended with ftill worfe fuccefs. The very firft day, the Termantines killed 700 of his legionaries; took a great convoy which was coming to the

(A) In this account we muft allow fomething for the exaggerations of fabulous hiftorians. There is no doubt, however, that Spain was at this time immenfely rich, and if we may believe Strabo, there was then a mine near Carthage which yielded every day 25,000 drams of filver, or about 300,000l. per annum.

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the Roman camp: and having defeated a conſiderable body of their horſe, puſhed them from poſt to poſt till they came to the edge of a precipice, where they all tumbled down, and were daſhed to pieces. In the mean time Servilius, who had been continued in his command with the title of *proconſul*, managed matters ſo ill, that Viriathus ſurrounded him on all ſides, and obliged him to ſue for peace. The terms offered to the Romans were very moderate; being only that Viriathus ſhould keep the country he at that time poſſeſſed, and the Romans remain maſters of all the reſt. This peace the proconſul was very glad to ſign, and afterwards procured its ratification by the ſenate and people of Rome.

24
The Romans ſurrounded on all ſides, and forced to conclude a peace with Viriathus.

The next year Q. Pompeius was continued in his command againſt the Numantines in Farther Spain, while Q. Servilius Cæpio, the new conſul, had for his province Hither Spain, where Viriathus had eſtabliſhed his new ſtate. Pompeius undertook to reduce Numantia by turning aſide the ſtream of the Durius, now the Douro, by which it was ſupplied with water; but, in attempting this, ſuch numbers of his men were cut off, that, finding himſelf unable to contend with the enemy, he was glad to make peace with them on much worſe terms than they had offered of their own accord. The peace, however, was ratified at Rome; but in the mean time Cæpio, deſirous of ſhowing his proweſs againſt the renowned Viriathus, prevailed on the Romans to declare war againſt him without any provocation. As Cæpio commanded an army greatly ſuperior to the Luſitanians, Viriathus thought proper to ſue for peace; but finding that Cæpio would be ſatisfied with nothing leſs than a ſurrender at diſcretion, he reſolved to ſtand his ground. In the mean time, the latter having bribed ſome of the intimate companions of Viriathus to murder him in his ſleep, he by that infamous method put an end to a war which had laſted 14 years, very little to the honour of the republic.

25
Viriathus treacherouſly murdered.

After the death of Viriathus, the Romans with like treachery ordered their new conſul Popilius to break the treaty with the Numantines. His infamous conduct met with the reward it deſerved; the Numantines ſallying out, put the whole Roman army to flight with ſuch ſlaughter, that they were in no condition to act during the whole campaign. Mancinus, who ſucceeded Popilius, met with ſtill worſe ſucceſs; his great army, conſiſting of 30,000 men, was utterly defeated by 4000 Numantines, and 20,000 of them killed in the purſuit. The remaining 10,000, with their general, were pent up by the Numantines in ſuch a manner that they could neither advance nor retreat, and would certainly have been all put to the ſword or made priſoners, had not the Numantines, with a generoſity which their enemies never poſſeſſed, offered to let them depart upon condition that a treaty ſhould be concluded with them upon very moderate terms. This the conſul very willingly promiſed, but found himſelf unable to perform. On the contrary, the people, not ſatisfied with declaring his treaty null and void, ordered him to be delivered up to the Numantines. The latter refuſed to accept him, unleſs he had along with him the 10,000 men whom they had relieved as before related. At laſt, after the conſul had remained a whole day before the city, his ſucceſſor Furius, thinking this a ſufficient recompenſe to the Numantines for breaking the treaty, ordered him to be received again into the camp. However, Furius did not chuſe to engage with ſuch a deſperate and reſolute enemy as the Numantines had ſhowed themſelves; and the war with them was diſcontinued till the year 133 B. C. when Scipio Æmilianus, the deſtroyer of Carthage, was ſent againſt them. Againſt this renowned commander the Numantines with all their valour were not able to contend. Scipio, having with the utmoſt care introduced ſtrict diſcipline among his troops, and reformed the abuſes which his predeceſſors had ſuffered in their armies, by degrees brought the Romans to face their enemies, which at his arrival they had abſolutely refuſed to do. Having then ravaged all the country round the town, it was ſoon blocked up on all ſides, and the inhabitants began to feel the want of proviſions. At laſt they reſolved to make one deſperate attempt for their liberty, and either to break through their enemies, or periſh in the attempt. With this view they marched out in good order by two gates, and fell upon the works of the Romans with the utmoſt fury. The Romans, unable to ſtand this deſperate ſhock, were on the point of yielding, when Scipio, haſtening to the places attacked, with no fewer than 20,000 men, the unhappy Numantines were at laſt driven into the city, where they ſuſtained for a little longer the miſeries of famine. Finding at laſt, however, that it was altogether impoſſible to hold out, it was reſolved by the majority to ſubmit to the pleaſure of the Roman commander. But this reſolution was not univerſally approved. Many ſhut themſelves up in their houſes, and died of hunger, while even thoſe who had agreed to ſurrender repented their offer, and ſetting fire to their houſes, periſhed in the flames with their wives and children, ſo that not a ſingle Numantine was left alive to grace the triumph of the conqueror of Carthage.

26
The Romans defeated by the Numantines.

Spain.

27
Scipio Æmilianus ſent againſt them.

An. 133. B. C.

28
Miſerable end of the people.

After the deſtruction of Numantia the whole of Spain ſubmitted to the Roman yoke; and nothing remarkable happened till the times of the Cimbri, when a prætorian army was cut off in Spain by the Luſitanians. From this time nothing remarkable occurs in the hiſtory of Spain till the civil war between Marius and Sylla. The latter having cruſhed the Marian faction, as related under the article ROME, proſcribed all thoſe that had ſided againſt him whom he could not immediately deſtroy. Among theſe was Sertorius, a man of conſummate valour and experience in war. He had been appointed prætor of Spain by Marius; and upon the overthrow of Marius, retired to that province. Sylla no ſooner heard of his arrival in that country, than he ſent thither one Caius Annius with a powerful army to drive him out. As Sertorius had but few troops along with him, he diſpatched one Julius Salinator with a body of 6000 men to guard the paſſes of the Pyrenees, and to prevent Annius from entering the country. But Salinator having been treacherouſly murdered by aſſaſſins hired by Annius for that purpoſe, he no longer met with any obſtacle; and Sertorius was obliged to embark for the coaſt of Africa with 3000 men, being all he had now remaining. With theſe he landed in Mauritania; but as his men were ſtraggling careleſsly about, great numbers of them were cut off by the Barbarians. This new misfortune obliged Sertorius to re-embark for Spain; but finding the whole coaſt lined with the troops of Annius, he put to ſea again, not knowing what courſe to ſteer. In this new voyage he met with a ſmall fleet of Cilician pirates; and having prevailed with

29
Sertorius ſupports the Marian faction in Spain.

30
Is driven out, and undergoes many hardſhips.

with them to join him, he made a deſcent on the coaſt of Iviça, overpowered the garriſon left there by Annius, and gained a conſiderable booty. On the news of this victory Annius ſet ſail for Iviça, with a conſiderable ſquadron, having 5000 land forces on board. Sertorius, not intimidated by the ſuperiority of the enemy, prepared to give them battle. But a violent ſtorm ariſing, moſt of the ſhips were driven on ſhore and daſhed to pieces, Sertorius himſelf with great difficulty eſcaping with the ſmall remains of his fleet. For ſome time he continued in great danger, being prevented from putting to ſea by the fury of the waves, and from landing by the enemy; at laſt, the ſtorm abating, he paſſed the ſtraits of Gades, now Gibraltar, and landed near the mouth of the river Bætis. Here he met with ſome ſeamen newly arrived from the Atlantic or Fortunate iſlands; and was ſo charmed with the account which they gave him of thoſe happy regions, that he reſolved to retire thither to ſpend the reſt of his life in quiet and happineſs. But having communicated this deſign to the Cilician pirates, they immediately abandoned him, and ſet ſail for Africa, with an intention to aſſiſt one of the barbarous kings againſt his ſubjects who had rebelled. Upon this Sertorius ſailed thither alſo, but took the oppoſite ſide; and having defeated the king named *Aſcalis*, obliged him to ſhut himſelf up in the city of Tingis, now Tangier, which he cloſely beſieged. But in the mean time Pacianus, who had been ſent by Sylla to aſſiſt the king, advanced with a conſiderable army againſt Sertorius. Upon this the latter, leaving part of his forces before the city, marched with the reſt to meet Pacianus, whoſe army, though greatly ſuperior to his own in number, he entirely defeated; killed the general, and took all his forces priſoners.—The fame of this victory ſoon reached Spain; and the Luſitanians, being threatened with a new war from Annius, invited Sertorius to head their armies. With this requeſt he very readily complied, and ſoon became very formidable to the Romans. Titus Didius, governor of that part of Spain called *Bætica*, firſt entered the liſts with him; but he being defeated, Sylla next diſpatched Metellus, reckoned one of the beſt commanders in Rome, to ſtop the progreſs of this new enemy. But Metellus, notwithſtanding all his experience, knew not how to act againſt Sertorius, who was continually changing his ſtation, putting his army into new forms, and contriving new ſtratagems. On his firſt arrival he ſent for L. Domitius, then prætor of Hither Spain, to his aſſiſtance; but Sertorius being informed of his march, detached Hirtuleius, or Herculeius, his quæſtor, againſt him, who gave him a total overthrow. Metellus then diſpatched Lucius Lollius prætor of Narbonne Gaul againſt Hirtuleius; but he met with no better ſucceſs, being utterly defeated, and his lieutenant-general killed.

31
Lands in Africa, and carries on a ſucceſsful war in that country.

32
Returns to Spain, and defeats the Romans there.

33
Erects Luſitania into a republic.

The fame of theſe victories brought to the camp of Sertorius ſuch a number of illuſtrious Roman citizens of the Marian faction, that he formed a deſign of erecting Luſitania into a republic in oppoſition to that of Rome. Sylla was continually ſending freſh ſupplies to Metellus; but Sertorius with a handful of men, accuſtomed to range about the mountains, to endure hunger and thirſt, and live expoſed to the inclemencies of the weather, ſo haraſſed the Roman army, that Metellus himſelf began to be quite diſcouraged. At laſt, Sertorius hearing that Metellus had ſpoken diſreſpectfully of his courage, challenged his antagoniſt to end the war by ſingle combat; but Metellus very prudently declined the combat, as being advanced in years; yet this refuſal brought upon him the contempt of the unthinking multitude, upon which Metellus reſolved to retrieve his reputation by ſome ſignal exploit, and therefore laid ſiege to Lacobriga, a conſiderable city in thoſe parts. This he hoped to reduce in two days, as there was but one well in the place; but Sertorius having previouſly removed all thoſe who could be of no ſervice during the ſiege, and conveyed 6000 ſkins full of water into the city, Metellus continued a long time before it without making any impreſſion. At laſt, his proviſions being almoſt ſpent, he ſent out Aquinus at the head of 6000 men to procure a new ſupply; but Sertorius falling unexpectedly upon them, cut in pieces or took the whole detachment; the commander himſelf being the only man who eſcaped to carry the news of the diſaſter; upon which Metellus was obliged to raiſe the ſiege with diſgrace.

34
Obliges Metellus to raiſe the ſiege of Lacobriga.

35
Civilizes the Luſitanians.

And now Sertorius, having gained ſome intervals of eaſe in conſequence of the many advantages he had obtained over the Romans, began to civilize his new ſubjects. Their ſavage and furious manner of fighting he changed for the regular order and diſcipline of a well-formed army; he beſtowed liberally upon them gold and ſilver to adorn their arms, and by converſing familiarly with them, prevailed with them to lay aſide their own dreſs for the Roman *toga*. He ſent for all the children of the principal people, and placed them in the great city of Oſca, now Hueſca, in the kingdom of Aragon, where he appointed them maſters to inſtruct them in the Roman and Greek learning, that they might, as he pretended, be capable of ſharing with him the government of the republic. Thus he made them really hoſtages for the good behaviour of their parents; however, the latter were greatly pleaſed with the care he took of their children, and all Luſitania were in the higheſt degree attached to their new ſovereign. This attachment he took care to heighten by the power of ſuperſtition; for having procured a young hind of a milk-white colour, he made it ſo tame that it followed him wherever he went; and Sertorius gave out to the ignorant multitude, that this hind was inſpired by Diana, and revealed to him the deſigns of his enemies, of which he always took care to be well informed by the great numbers of ſpies whom he employed.

36
Pompey the Great ſent againſt him.

While Sertorius was thus employed in eſtabliſhing his authority, the republic of Rome, alarmed at his ſucceſs, reſolved to cruſh him at all events. Sylla was now dead, and all the eminent generals in Rome ſolicited this honourable though dangerous employment. After much debate a decree was paſſed in favour of Pompey the Great, but without recalling Metellus. In the mean time, the troops of one Perpenna, or Perperna, had, in ſpite of all that their general could do, abandoned him, and taken the oath of allegiance to Sertorius. This was a moſt ſignal advantage to Sertorius; for Perpenna commanded an army of 33,000 men, and had come into Spain with a deſign to ſettle there as Sertorius had done; but as he was deſcended from one of the firſt families of Rome, he thought it below his dignity to ſerve under any general, however eminent he might be. But the troops of Perperna were of a different opinion; and therefore declaring that they would

ſerve

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serve none but a general who could defend himself, they to a man joined Sertorius; upon which Perperna himself finding he could do no better, consented to serve also as a subaltern.

37 Sertorius besieges Lauron.

On the arrival of Pompey in Spain, several of the cities which had hitherto continued faithful to Sertorius began to waver; upon which the latter resolved, by some signal exploit, to convince them that Pompey could no more screen them from his resentment than Metellus. With this view he laid siege to Lauron, now Lirias, a place of considerable strength. Pompey, not doubting but he should be able to raise the siege, marched quite up to the enemy's lines, and found means to inform the garrison that those who besieged them were themselves besieged, and would soon be obliged to retire with loss and disgrace. On hearing this message, "I will teach Sylla's disciple (said Sertorius), that it is the duty of a general to look behind as well as before him." Having thus spoken, he sent orders to a detachment of 6000 men, who lay concealed among the mountains, to come down and fall upon his rear if he should offer to force the lines. Pompey, surprised at their sudden appearance, durst not stir out of his camp; and in the mean time the besieged, despairing of relief, surrendered at discretion; upon which Sertorius granted them their lives and liberty, but reduced their city to ashes.

38 Takes and burns it in the sight of Pompey.

39 Defeats Pompey on the banks of the Sucro.

While Sertorius was thus successfully contending with Pompey, his questor Hirtuleius was entirely defeated by Metellus, with the loss of 40,000 men; upon which Sertorius advanced with the utmost expedition to the banks of the Sucro in Tarraconian Spain, with a design to attack Pompey before he could be joined by Metellus. Pompey, on his part, did not decline the combat; but, fearing that Metellus might share the glory of the victory, advanced with the greatest expedition. Sertorius put off the battle till towards the evening; Pompey, though he knew that the night would prove disadvantageous to him, whether vanquished or victorious, because his troops were unacquainted with the country, resolved to venture an engagement, especially as he feared that Metellus might arrive in the mean time, and rob him of part of the glory of conquering so great a commander. Pompey, who commanded his own right wing, soon obliged Perperna, who commanded Sertorius's left, to give way. Hereupon Sertorius himself, taking upon him the command of that wing, brought back the fugitives to the charge, and obliged Pompey to fly in his turn. In his flight he was overtaken by a gigantic African, who had already lifted up his hand to discharge a blow at him with his broad sword; but Pompey prevented him by cutting off his right hand at one blow. As he still continued his flight, he was wounded and thrown from his horse; so that he would certainly have been taken prisoner, had not the Africans who pursued him quarrelled about the rich furniture of his horse. This gave an opportunity to the general to make his escape; so that at length he reached his camp with much difficulty. But in the mean time Afranius, who commanded the left wing of the Roman army, had entirely defeated the wing which Sertorius had left, and even pursued them so close that he entered the camp along with them. Sertorius, returning suddenly, found the Romans busy in plundering the tents; when taking advantage of their situation, he drove them out with great slaughter, and retook their camp. Next day he offered battle a second time to Pompey; but Metellus then coming up with all his forces, he thought proper to decline an engagement with both commanders. In a few days, however, Pompey and Metellus agreed to attack the camp of Sertorius. The event was similar to that of the former battle; Metellus defeated Perperna, and Sertorius routed Pompey. Being then informed of Perperna's misfortune, he hastened to his relief; rallied the fugitives, and repulsed Metellus in his turn, wounded him with his lance, and would certainly have killed him, had not the Romans, ashamed to leave their general in distress, hastened to his assistance, and renewed the fight with great fury. At last Sertorius was obliged to quit the field, and retire to the mountains. Pompey and Metellus hastened to besiege him; but while they were forming their camp, Sertorius broke through their lines, and escaped into Lusitania. Here he soon raised such a powerful army, that the Roman generals, with their united forces, did not think proper to venture an engagement with him. They could not, however, resist the perpetual attacks of Sertorius, who now drove them from place to place, till he obliged them to separate; the one went into Gaul, and the other to the foot of the Pyrenees.

40 Pompey defeated a second time.

41 Pompey and Metellus driven from Spain by Sertorius.

42 Sertorius treacherously murdered.

Ant. Ch. B. [illegible]

Thus did this celebrated commander triumph over all the power of the Romans; and there is little doubt but he would have continued to make head against all the other generals whom the republic could have sent, had he not been assassinated at an entertainment by the infamous treachery of Perperna, in 73 B. C. after he had made head against the Roman forces for almost 10 years. Pompey was no sooner informed of his death, than, without waiting for any new succours, he marched against the traitor, whom he easily defeated and took prisoner; and having caused him to be executed, thus put an end, with very little glory, to a most dangerous war.

Many of the Spanish nations, however, still continued to bear the Roman yoke with great impatience; and as the civil wars which took place first between Julius Cæsar and Pompey, and afterwards between Octavianus and Antony, diverted the attention of the republic from Spain, by the time that Augustus had become sole master of the Roman empire, they were again in a condition to assert their liberty. The CANTABRIANS and ASTURIANS were the most powerful and valiant nations at that time in Spain; but, after incredible efforts, they were obliged to lay down their arms, or rather were almost exterminated by Agrippa, as related under these articles.

43 Spain under the Romans.

When the Romans first became masters of the western peninsula of Europe, to which, as we have said, they gave the name of Hispania, it was divided into two provinces, called *Citerior* and *Ulterior*, which were governed, sometimes by prætors, and sometimes by proconsuls. In the distribution of the empire by Augustus, *Hispania Citerior* contained the modern provinces of Gallicia, the Asturias, Biscay, Navarre, Leon, the two Castiles, Arragon, Catalonia, Murcia, and Valencia; and was denominated *Provincia Tarraconensis*, from the city of Tarragona in Catalonia, which was then the seat of government. *Hispania Ulterior* was subdivided into Bætica, including the provinces now called Granada and Andalufia; and Lufitania, comprehending the greateft part of Eftremadura, and the modern kingdom of Portugal. The province called *Tarraconenfis* was then inhabited by the following tribes, viz. the *Aufetani*, occupying the fea coaft, at the north-eaft, between the Ter and the Lobregat, and having for their capital Germa; the *Ceretani*, inhabiting the diftrict of Cerdana, at the foot of the Pyrenees, whofe capital was *Julia*, the modern Llivia; the *Valetani*, occupying the fea coaft between the rivers Ter and Lobregat, in the immediate neighbourhood of the *Aufetani*, and whofe capital was Barcelona; the *Cofetani* to the left of the mouth of the Ebro, with Tarragona for their capital; the *Locetani*, on the left bank of the river *Sicoris*; the *Illergetes*, extending from that river to the fmall ftream Gallego, which joins the Ebro near Zaragoza, whofe capital was Lerida; the *Jacetani* in the northern extremity of Aragon, having their feat of government at Jaca; the *Vafcones* in Navarre, and the *Varduii* in the modern Guipuzcoa. Thefe nations occupied the fouthern and eaftern parts of the province. The northern was poffeffed by the *Carifti*, the *Oftregones*, both in Bifcay; the *Cantabri*, cantoned near the fource of the Ebro, and along the bay of Bifcay; the *Aftures* in Afturias and part of Leon; the *Callæci* in Gallicia; the *Vacceni* along the Douro; the *Arebaci* in Old Caftile; the *Celtiberi*, between the Ebro and the fource of the Tagus, and many others of inferior note.

Lufitania was held by three principal tribes, the *Lufitani*, occupying the greater part of the province, and having for their capital the modern Lifbon; the *Vettones* and the *Celtici*.

Bætica was inhabited by the *Turdetani*, the *Turduli*, the *Baftitani*, and the *Bafluli*.

All thefe diftricts, with their principal towns, are minutely treated of by Dr Playfair, in the firft volume of his geography.

44
State of Roman Spain.

When incorporated with the Roman empire, Spain partook of its tranquillity, and received in exchange for her liberty, at leaft wife laws and a mild government. If fhe could not prevent herfelf from falling under the dominion of the mafters of the world, fhe was at leaft the moft powerful, the richeft, and the happieft province of their empire. Columella has left us an interefting account of her agriculture under the firft emperors. The tradition of her ancient population is probably exaggerated, but the ruins of feveral towns prove it to have been confiderable. It was increafed by a great many Roman families after the conqueft; feveral legions were eftablifhed in Spain; 25 colonies were diftributed in the moft fertile parts of the country, and intermarried with the inhabitants. After a while the Spaniards, feeing in their mafters only countrymen, were the firft to folicit the rights of Roman citizens, by which they were completely confolidated. Some municipal towns went fo far as to defire permiffion to take the title of colonies, though in the change they loft their independence, nearly in the fame manner as certain proprietors of lands under the feudal fyftem converted their domains into fiefs, in order to enjoy the honours attached to them. The government was, in general, milder in Spain than in the other Roman provinces. The adminiftration was carried on in the towns by magiftrates named by themfelves, and the different provinces were under the fuperintendance of pretors, proconfuls, and legates or deputies, according to the different eras of the Roman empire; thofe in their refpective departments took care of all the works of public utility, the aqueducts, baths, circufes, and highways, whofe magnificent ruins are ftill exifting; but they were principally employed in collecting the revenues of the ftate, which were fingularly analogous to thofe of the prefent times. They principally arofe from dues, fines, or alienations of property, and the produce of the mines. Spain at that time drew from her own mines the fame riches the now draws from the new world, and they were diftributed in nearly the fame manner. One part belonged to the ftate, and the other to the inhabitants of the country, who paid a certain duty on the metals which they procured from the mines. Their returns went on increafing, and depended entirely on the number of hands which could be devoted to work in the mines. An employment, fo laborious, however, which required a numerous population, tended to diminifh that population by the exceffive fatigues which it occafioned. Agriculture alfo fuffered by the accumulation of eftates in the hands of a few wealthy landholders. By the little attention paid to it by the proprietors, and by the defects infeparable from the fyftem of cultivation by means of flaves, commerce and induftry languifhed; and Spain, after having fhared in the fplendor of the Roman empire, was beginning to participate in its decline, when a new calamity, by completing her ruin, prepared her regeneration.

This calamity was the irruption of the northern hordes, which foon involved Spain in the general attack. This province was invaded firft by the Franks, who in the third century had entered Gaul with a formidable force.

45
Spain invaded by the Franks.
A. D. 260.

The Rhine, though dignified by the title of Safeguard of the Provinces, was an imperfect barrier againft the daring fpirit of enterprife with which the Franks were actuated. Their rapid devaftations ftretched from the river to the foot of the Pyrenees; nor were they ftopped by thofe mountains. Spain, which had never dreaded, was unable to refift the inroads of the Germans. During 12 years, the greateft part of the reign of Gallienus, that opulent country was the theatre of unequal and deftructive hoftilities. Tarragona, the flourifhing capital of a peaceful province, was facked and almoft deftroyed; and fo late as the days of Orofius, who wrote in the 5th century, wretched cottages, fcattered amidft the ruins of magnificent cities, ftill recorded the rage of the barbarians. When the exhaufted country no longer fupplied a variety of plunder, the Franks feized on fome veffels, and retreated to Mauritania.

46
By the Suevi, Vandals, &c.
An. 409.

The fituation of Spain, feparated, on all fides, from the enemies of Rome, by the fea, by the mountains, and by intermediate provinces, had fecured the long tranquillity of that remote and fequeftered country; and we may obferve, as a fure fymptom of domeftic happinefs, that, in a period of 400 years, Spain furnifhed very few materials to the hiftory of the Roman empire. The footfteps of the Barbarians, who, in the reign of Gallienus, had penetrated beyond the Pyrenees, were foon obliterated by the return of peace; and in the 4th century of the Chriftian era, the cities of Emerita or Merida, of Corduba, Seville, Bracara, and Tarragona, were numbered with the moft illuftrious of the Roman world.

The

The various plenty of the animal, the vegetable, and the mineral kingdoms, was improved and manufactured by the skill of an industrious people; and the peculiar advantages of naval stores contributed to support an extensive and profitable trade. The arts and sciences flourished under the protection of the emperors; and if the character of the Spaniards was enfeebled by peace and servitude, the hostile approach of the Germans, who had spread terror and desolation from the Rhine to the Pyrenees, seemed to rekindle some sparks of military ardour. As long as the defence of the mountains was intrusted to the hardy and faithful militia of the country, they successfully repelled the frequent attempts of the Barbarians. But no sooner had the national troops been compelled to resign their post to the Honorian bands, in the service of Constantine, than the gates of Spain were treacherously betrayed to the public enemy, about ten months before the sack of Rome by the Goths. The consciousness of guilt, and the thirst of rapine, prompted the mercenary guards of the Pyrenees to desert their station; to invite the arms of the Suevi, the Vandals, and the Alani; and to swell the torrent which was poured with irresistible violence from the frontiers of Gaul to the sea of Africa. The misfortunes of Spain may be described in the language of its most eloquent historian, who has concisely expressed the passionate, and perhaps exaggerated, declamations of contemporary writers. "The irruption of these nations was followed by the most dreadful calamities; as the Barbarians exercised their indiscriminate cruelty on the fortunes of the Romans and the Spaniards; and ravaged with equal fury the cities and the open country. The progress of famine reduced the miserable inhabitants to feed on the flesh of their fellow creatures; and even the wild beasts, who multiplied, without controul, in the desert, were exasperated, by the taste of blood, and the impatience of hunger, boldly to attack and devour their human prey. Pestilence soon appeared, the inseparable companion of famine; a large proportion of the people was swept away; and the groans of the dying excited only the envy of their surviving friends. At length the Barbarians, satiated with carnage and rapine, and afflicted by the contagious evil which they themselves had introduced, fixed their permanent seats in the depopulated country. The ancient Gallicia, whose limits included the kingdom of Old Castile, was divided between the Suevi and the Vandals, the Alani were scattered over the provinces of Carthagena and Lusitania, and from the Mediterranean to the Atlantic ocean; and the fruitful territory of Bætica was allotted to the Silingi, another branch of the Vandalic nation. After regulating this partition, the conquerors contracted with their new subjects some reciprocal engagements of protection and obedience: the lands were again cultivated; and the towns and villages were again occupied by a captive people. The greatest part of the Spaniards was even disposed to prefer this new condition of poverty and barbarism, to the severe oppressions of the Roman government; yet there were many who still asserted their native freedom, and who refused, more especially in the mountains of Gallicia, to submit to the barbarian yoke *."

* Mariana de reb. Hisp. par. 1. 5. v.

An. 414. The important present of the heads of Jovinus and Sebastian, had approved the friendship of Adolphus, and restored Gaul to the obedience of his brother Honorius. Peace was incompatible with the situation and temper of the king of the Goths. He readily accepted the proposal of turning his victorious arms against the barbarians of Spain; the troops of Constantius intercepted his communication with the sea-ports of Gaul, and gently pressed his march towards the Pyrenees. He passed the mountains, and surprised, in the name of the emperor, the city of Barcelona. The fondness of Adolphus for his Roman bride, Placidia, was not abated by time or possession; and the birth of a son, surnamed, from his illustrious grandsire, Theodosius, appeared to fix him for ever in the interest of the republic. The loss of that infant, whose remains were deposited in a silver coffin in one of the churches near Barcelona, afflicted his parents; but the grief of the Gothic king was suspended by the labours of the field: and the course of his victories was soon interrupted by domestic treason. He had imprudently received into his service one of the followers of Sarus; a barbarian of a daring spirit, but of a diminutive stature; whose secret desire of revenging the death of his beloved patron, was continually irritated by the sarcasms of his insolent master. Adolphus was An. 415. assassinated in the palace of Barcelona; the laws of the succession were violated by a tumultuous faction; and a stranger to the royal race, Singeric, the brother of Sarus himself, was seated on the Gothic throne. The first act of his reign was the inhuman murder of the six children of Adolphus, the issue of a former marriage, whom he tore, without pity, from the feeble arms of a venerable bishop. The unfortunate Placidia, instead of the respectful compassion, which she might have excited in the most savage breasts, was treated with cruel and wanton insult. The daughter of the emperor Theodosius, confounded among a crowd of vulgar captives, was compelled to march on foot above 12 miles, before the horse of a barbarian, the assassin of a husband whom Placidia loved and lamented.

But Placidia soon obtained the pleasure of revenge; 47 and the view of her ignominious sufferings might rouse Conquered by the an indignant people against the tyrant, who was assassi- Goths. nated on the seventh day of his usurpation. After the An. 415 death of Singeric, the free choice of the nation bestowed —418. the Gothic sceptre on Wallia, whose warlike and ambitious temper appeared, in the beginning of his reign, extremely hostile to the republic. He marched, in arms, from Barcelona to the shores of the Atlantic ocean, which the ancients revered and dreaded as the boundary of the world. But when he reached the southern promontory of Spain, and, from the rock now covered by the fortress of Gibraltar, contemplated the neighbouring and fertile coast of Africa, Wallia resumed the designs of conquest, which had been interrupted by the death of Alaric. The winds and waves disappointed the enterprises of the Goths; and the minds of a superstitious people were deeply affected by the repeated disasters of storms and shipwrecks. In this disposition, the successor of Adolphus no longer refused to listen to a Roman ambassador, whose proposals were enforced by the real, or supposed, approach of a numerous army, under the conduct of the brave Constantius. A solemn treaty was stipulated and observed: Placidia was honourably restored to her brother; 600,000 measures of wheat were delivered to the hungry Goths; and Wallia engaged to draw his sword in the service of the empire. A bloody war was instantly excited among the barbarians of Spain; and the contending princes are said to have

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have addreffed their letters, their ambaffadors, and their hoftages, to the throne of the weftern emperor, exhorting him to remain a tranquil fpectator of their conteft; the events of which muft be favourable to the Romans, by the mutual flaughter of their common enemies. The Spanifh war was obftinately fupported, during three campaigns, with defperate valour, and various fuccefs; and the martial achievements of Wallia diffufed through the empire the fuperior renown of the Gothic hero. He exterminated the Silingi, who had irretrievably ruined the elegant plenty of the province of Bætica. He flew in battle the king of the Alani; and the remains of thofe Scythian wanderers, who efcaped from the field, inftead of choofing a new leader, humbly fought a refuge under the ftandard of the Vandals, with whom they were ever afterwards confounded. The Vandals themfelves, and the Suevi, yielded to the efforts of the invincible Goths. The promifcuous multitude of barbarians, whofe retreat had been intercepted, were driven into the mountains of Gallicia, where they ftill continued, in a narrow compafs, and on a barren foil, to exercife their domeftic and implacable hoftilities. In the pride of victory, Wallia was faithful to his engagements; he reftored his Spanifh conquefts to the obedience of Honorius; and the tyranny of the imperial officers foon reduced an oppreffed people to regret the time of their barbarian fervitude. While the event of the war was ftill doubtful, the firft advantages obtained by the arms of Wallia, had encouraged the court of Ravenna to decree the honours of a triumph to their feeble fovereign. He entered Rome like the ancient conquerors of nations; and if the monuments of fervile corruption had not long fince met with the fate which they deferved, we fhould probably find that a crowd of poets, and orators, of magiftrates and bifhops, applauded the fortune, the wifdom, and the invincible courage, of the emperor Honorius.

An. 42[illegible]. After the retreat of the Goths, the authority of Honorius had obtained a precarious eftablifhment in Spain; except only in the province of Gallicia, where the Suevi and the Vandals had fortified their camps, in mutual difcord, and hoftile independence. The Vandals prevailed; and their adverfaries were befieged in the Nervafcan hills, between Leon and Oviedo, till the approach of Count Afterius compelled, or rather provoked, the victorious barbarians to remove the fcene of the war to the plains of Bætica. The rapid progrefs of the Vandals foon required a more effectual oppofition; and the mafter-general Coftinus marched againft them with a numerous army of Romans and Goths. Vanquifhed in battle by an inferior enemy, Coftinus fled with difhonour to Tarragona; and this memorable defeat, which has been reprefented as the punifhment, was moft probably the effect, of his rafh prefumption. Seville and Carthagena became the reward, or rather the prey, of the ferocious conquerors; and the veffels which they found in the harbour of Carthagena, might eafily tranfport them to the ifles of Majorca and Minorca, where the Spanifh fugitives, as in a fecure recefs, had vainly concealed their families and their fortunes. The experience of navigation, and perhaps the profpect of Africa, encouraged the Vandals to accept the invitation which they received from Count Boniface; and the death of Gonderic ferved only to forward and animate the bold enterprife. In the room of a prince, not confpicuous for any fuperior powers of the mind or body, they acquired his baftard brother, the terrible Genferic; a name which, in the deftruction of the Roman empire, has deferved an equal rank with the names of Alaric and Attila. Almoft in the moment of his departure he was informed, that Hermanric, king of the Suevi, had prefumed to ravage the Spanifh territories, which he was refolved to abandon. Impatient of the infult, Genferic purfued the hafty retreat of the Suevi as far as Merida; precipitated the king and his army into the river Anas, and calmly returned to the fea fhore, to embark his victorious troops. The veffels which tranfported the Vandals over the modern ftraits of Gibraltar, a channel only twelve miles in breadth, were furnifhed by the Spaniards, who anxioufly wifhed their departure; and by the African general, who had implored their formidable affiftance.

An. 456. When Theodoric king of the Vifigoths encouraged Avitus to affume the purple, he offered his perfon and his forces, as a faithful foldier of the republic. The exploits of Theodoric foon convinced the world, that he had not degenerated from the warlike virtues of his anceftors. After the eftablifhment of the Goths in Aquitain, and the paffage of the Vandals into Africa, the Suevi, who had fixed their kingdom in Gallicia, afpired to the conqueft of Spain, and threatened to extinguifh the feeble remains of the Roman dominion. The provincials of Carthagena and Tarragona, afflicted by an hoftile invafion, reprefented their injuries and their apprehenfions. Count Fronto was difpatched, in the name of the emperor Avitus, with advantageous offers of peace and alliance; and Theodoric interpofed his weighty mediation, to declare that, unlefs his brother-in-law, the king of the Suevi, immediately retired, he fhould be obliged to arm in the caufe of juftice and of Rome. "Tell him," replied the haughty Rechiarius, "that I defpife his friendfhip and his arms; but that I fhall foon try, whether he will dare to expect my arrival under the walls of Thouloufe." Such a challenge urged Theodoric to prevent the bold defigns of his enemy: He paffed the Pyrenees at the head of the Vifigoths; the Franks and Burgundians ferved under his ftandard; and though he profeffed himfelf the dutiful fervant of Avitus, he privately ftipulated, for himfelf and his fucceffors, the abfolute poffeffion of his Spanifh conquefts. The two armies, or rather the two nations, encountered each other on the banks of the river Urbicus, about 12 miles from Aftorga; and the decifive victory of the Goths appeared for a while to have extirpated the name and kingdom of the Suevi. From the field of battle Theodoric advanced to Braga, their metropolis, which ftill retained the fplendid veftiges of its ancient commerce and dignity. His entrance was not polluted with blood, and the Goths refpected the chaftity of their female captives, more efpecially of the confecrated virgins; but the greateft part of the clergy and people were made flaves, and even the churches and altars were confounded in the univerfal pillage. The unfortunate king of the Suevi had efcaped to one of the ports of the ocean; but the obftinacy of the winds oppofed his flight; he was delivered to his implacable rival; and Rechiarius, who neither defired nor expected mercy, received, with manly conftancy, the death which he would probably have inflicted. After this bloody facrifice to policy or refentment, Theodoric carried his victorious

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victorious arms as far as Merida, the principal town of Luſitania, without meeting any reſiſtance, except from the miraculous powers of St Eulalia; but he was ſtopped in the full career of ſucceſs, and recalled from Spain, before he could provide for the ſecurity of his conqueſts. In his retreat towards the Pyrenees, he revenged his diſappointment on the country through which he paſſed; and in the ſack of Pallentia and Aſtorga, he ſhewed himſelf a faithleſs ally, as well as a cruel enemy.

45 Introduction of Chriſtianity. AD 586.—589.

Recared was the firſt Catholic king of Spain. He had imbibed the faith of his unfortunate brother, and he ſupported it with more prudence and ſucceſs. Inſtead of revolting againſt his father, Recared patiently expected the hour of his death. Inſtead of condemning his memory, he piouſly ſuppoſed, that the dying monarch had abjured the errors of Arianiſm, and recommended to his ſon the converſion of the Gothic nation. To accompliſh that ſalutary end, Recared convened an aſſembly of the Arian clergy and nobles, declared himſelf a Catholic, and exhorted them to imitate the example of their prince. The laborious interpretation of doubtful texts, or the curious purſuit of metaphyſical arguments, would have excited endleſs controverſy; and the monarch diſcreetly propoſed to his illiterate audience, two ſubſtantial and viſible arguments, the teſtimony of Earth and of Heaven. The *Earth* had ſubmitted to the Nicene ſynod: the Romans, the Barbarians, and the inhabitants of Spain, unanimouſly profeſſed the ſame orthodox creed; and the Viſigoths reſiſted, almoſt alone, the conſent of the Chriſtian world. A ſuperſtitious age was prepared to reverence, as the teſtimony of *Heaven*, the preternatural cures which were performed by the ſkill or virtue of the Catholic clergy; the baptiſmal fonts of Oſſet in Bætica, which were ſpontaneouſly repleniſhed each year, on the vigil of Eaſter; and the miraculous ſhrine of St Martin of Tours, which had already converted the Suevic prince and people of Gallicia. The Catholic king encountered ſome difficulties on this important change of the national religion. A conſpiracy, ſecretly fomented by the queen-dowager, was formed againſt his life; and two counts excited a dangerous revolt in the Narbonneſe Gaul. But Recared diſarmed the conſpirators, defeated the rebels, and executed ſevere juſtice; which the Arians, in their turn, might brand with the reproach of perſecution. Eight biſhops, whoſe names betray their Barbaric origin, abjured their errors; and all the books of Arian theology were reduced to aſhes, with the houſe in which they had been purpoſely collected. The whole body of the Viſigoths and Suevi were allured or driven into the pale of the Catholic communion; the faith, at leaſt, of the riſing generation, was fervent and ſincere; and the devout liberality of the Barbarians enriched the churches and monaſteries of Spain. Seventy biſhops aſſembled in the council of Toledo, received the ſubmiſſion of their conquerors; and the zeal of the Spaniards improved the Nicene creed, by declaring the proceſſion of the Holy Ghoſt from the Son, as well as from the Father; a weighty point of doctrine, which produced, long afterwards, the ſchiſm of the Greek and Latin churches. The royal proſelyte immediately ſaluted and conſulted Pope Gregory, ſurnamed the Great, a learned and holy prelate, whoſe reign was diſtinguiſhed by the converſion of heretics and infidels. The ambaſſadors of Recared reſpectfully offered on the threſhold of the Vatican his rich preſents of gold and gems: they accepted, as a lucrative exchange, the hairs of St John the Baptiſt; a croſs, which incloſed a ſmall piece of the true wood; and a key, that contained ſome particles of iron which had been ſcraped from the chains of St Peter*.

* Gibbon's Rome, 4to vol. iii. p. 549.

49 Legiſlative aſſemblies of the Goths in Spain.

After their converſion from idolatry or hereſy, the Franks and the Viſigoths were diſpoſed to embrace, with equal ſubmiſſion, the inherent evils, and the accidental benefits of ſuperſtition. But the prelates of France, long before the extinction of the Merovingian race, had degenerated into fighting and hunting barbarians. They diſdained the uſe of ſynods; forgot the laws of temperance and chaſtity, and preferred the indulgence of private ambition and luxury, to the greateſt intereſt of the ſacerdotal profeſſion. The biſhops of Spain reſpected themſelves, and were reſpected by the public: their indiſſoluble union diſguiſed their vices, and confirmed their authority; and the regular diſcipline of the church introduced peace, order, and ſtability into the government of the ſtate. From the reign of Recared, the firſt Catholic king, to that of Witiza, the immediate predeceſſor of the unfortunate Roderic, ſixteen national councils were ſucceſſively convened. The ſix metropolitans, Toledo, Seville, Merida, Braga, Tarragona and Narbonne, preſided according to their reſpective ſeniority; the aſſembly was compoſed of their ſuffragan biſhops, who appeared in perſon, or by their proxies; and a place was aſſigned to the moſt holy, or opulent, of the Spaniſh abbots. During the firſt three days of the convocation, as long as they agitated the eccleſiaſtical queſtions of doctrine and diſcipline, the profane laity was excluded from their debates; which were conducted, however, with decent ſolemnity. But, on the morning of the fourth day, the doors were thrown open for the entrance of the great officers of the palace, the dukes and counts of the provinces, the judges of the cities, and the Gothic nobles; and the decrees of Heaven were ratified by the conſent of the people. The ſame rules were obſerved in the provincial aſſemblies, the annual ſynods, which were empowered to hear complaints, and to redreſs grievances; and a legal government was ſupported by the prevailing influence of the Spaniſh clergy. The biſhops who, in each revolution, were prepared to flatter the victorious, and to inſult the proſtrate, laboured, with diligence and ſucceſs, to kindle the flames of perſecution, and to exalt the mitre above the crown. Yet the national councils of Toledo, in which the free ſpirit of the Barbarians was tempered, and guided by epiſcopal policy, have eſtabliſhed ſome prudent laws for the benefit of the king and people. The vacancy of the throne was ſupplied by the choice of the biſhops and palatines; and after the failure of the line of Alaric, the regal dignity was ſtill limited to the pure and noble blood of the Goths. The clergy, who anointed their lawful prince, always recommended, and ſometimes practiſed, the duty of allegiance; and the ſpiritual cenſures were denounced on the heads of the impious ſubjects, who ſhould reſiſt his authority, conſpire againſt his life, or violate, by an indecent union, the chaſtity even of his widow. But the monarch himſelf, when he aſcended the throne, was bound by a reciprocal oath to God and his people, that he would faithfully execute his important truſt. The real or imaginary faults of his adminiſtration were ſubject to the

the controul of a powerful ariſtocracy; and the biſhops and palatines were guarded by a fundamental privilege that they ſhould not be degraded, impriſoned, tortured, nor puniſhed with death, exile, or confiſcation, unleſs by the free and public judgement of their peers.

50 Code of the Viſigoths.

One of theſe legiſlative councils of Toledo, examined and ratified the code of laws which had been compiled by a ſucceſſion of Gothic kings, from the fierce Eurice, to the devout Egica. As long as the Viſigoths themſelves were ſatisfied with the rude cuſtoms of their anceſtors, they indulged their ſubjects of Aquitaine and Spain in the enjoyment of the Roman law. Their gradual improvement in arts, in policy, and at length in religion, encouraged them to imitate, and to ſuperſede, theſe foreign inſtitutions, and to compoſe a code of civil and criminal juriſprudence, for the uſe of a great and united people. The ſame obligations, and the ſame privileges, were communicated to the nations of the Spaniſh monarchy; and the conquerors, inſenſibly renouncing the Teutonic idiom, ſubmitted to the reſtraints of equity, and exalted the Romans to the participation of freedom. The merit of this impartial policy was enhanced by the ſituation of Spain, under the reign of the Viſigoths. The provincials were long ſeparated from their Arian maſters, by the irreconcileable difference of religion. After the converſion of Recared had removed the prejudices of the Catholics, the coaſts, both of the ocean and Mediterranean, were ſtill poſſeſſed by the Eaſtern emperors, who ſecretly excited a diſcontented people to reject the yoke of the barbarians, and to aſſert the name and dignity of Roman citizens. The allegiance of doubtful ſubjects is indeed moſt effectually ſecured by their own perſuaſion, that they hazard more in a revolt, than they can hope to obtain by a revolution; but it has appeared ſo natural to oppreſs thoſe whom we hate and fear, that the contrary ſyſtem well deſerves the praiſe of wiſdom and moderation.

The Gothic princes continued to reign over a conſiderable part of Spain till the beginning of the 8th century, when their empire was overthrown by the Saracens. During this period, they had entirely expelled the eaſtern emperors from what they poſſeſſed in Spain, and even made conſiderable conqueſts in Barbary; but towards the end of the 7th century the Saracens overran all that part of the world with a rapidity which nothing could reſiſt; and having ſoon poſſeſſed themſelves of the Gothic dominions in Barbary, they made a deſcent upon Spain about the year 711 or 712. The king of the Goths at that time was called *Roderic*, and by his bad conduct had occaſioned great diſaffection among his ſubjects. He therefore determined to put all to the iſſue of a battle, knowing that he could not depend upon the fidelity of his own people if he allowed the enemy time to tamper with them. The two armies met in a plain near Xeres in Andaluſia. The Goths began the attack with great fury; but though they fought like men in deſpair, they were at laſt defeated with exceſſive ſlaughter, and their king himſelf was ſuppoſed to have periſhed in the battle, being never more heard of.

51 The Gothic kingdom overthrown by the Saracens.

An. 711.

By this battle the Moors in a ſhort time rendered themſelves maſters of almoſt all Spain. The poor remains of the Goths were obliged to retire into the mountainous parts of Aſturias, Burgos, and Biſcay: the inhabitants of Aragon, Catalonia, and Navarre, though they might have made a conſiderable ſtand againſt the enemy, choſe for the moſt part to retire into France. In 718, however, the power of the Goths began again to revive under Don Pelagio or Pelayo, a prince of the royal blood, who headed thoſe that had retired to the mountains after the fatal battle of Xeres. The place where he firſt laid the foundation of his government was in the Aſturias, in the province of Liebana, about nine leagues in length and four in breadth. This is the moſt inland part of the country, full of mountains enormouſly high, and ſo much fortified by nature, that its inhabitants are capable of reſiſting almoſt any number of invaders. Alakor the Saracen governor was no ſooner informed of this revival of the Gothic kingdom, than he ſent a powerful army, under the command of one Alchaman, to cruſh Don Pelagio before he had time to eſtabliſh his power. The king, though his forces were ſufficiently numerous (every one of his ſubjects arrived at man's eſtate being a ſoldier), did not think proper to venture a general engagement in the open field; but taking poſt with part of them himſelf in a cavern in a very high mountain, he concealed the reſt among precipices, giving orders to them to fall upon the enemy as ſoon as they ſhould perceive him attacked by them. Theſe orders were punctually executed, though indeed Don Pelagio himſelf had repulſed his enemies, but not without a miracle, as the Spaniſh hiſtorians pretend. The ſlaughter was dreadful; for the troops who lay in ambuſcade joining the reſt, and rolling down huge ſtones from the mountains upon the Moors (the name by which the Saracens were known in Spain), no fewer than 124,000 of theſe unhappy people periſhed in one day. The remainder fled till they were ſtopped by a river, and beginning to coaſt it, part of a mountain ſuddenly fell down, ſtopped up the channel of the river, and either cruſhed or drowned, by the ſudden riſing of the water, almoſt every one of that vaſt army.

52 The power of the Goths revives under Pelagio.

An. 718.

53 He gives the Saracens a dreadful overthrow.

54 Another army cut in pieces or taken.

The Moors were not ſo much diſheartened by this diſaſter, but that they made a ſecond attempt againſt Don Pelagio. Their ſucceſs was as bad as ever, the greateſt part of their army being cut in pieces or taken; in conſequence of which, they loſt all the Aſturias, and never dared to enter the liſts with Pelagio afterwards. Indeed, their bad ſucceſs had in a great meaſure taken from them the deſire of conquering a country where little or nothing was to be gained; and therefore they rather directed their force againſt France, where they hoped for more plunder. Into this country they poured in prodigious multitudes; but were utterly defeated, in 732, by Charles Martel, with the loſs of 300,000 men, as the hiſtorians of thoſe times pretend.

The ſubſequent hiſtory of Spain is rendered ſo confuſed by the numerous kingdoms that were eſtabliſhed either by the Chriſtians or the Moors, that ſome chronological guide is neceſſary to make it intelligible. Before purſuing the thread of the narration, we ſhall lay before our readers the following chronological table of the cotemporary monarchs from Pelagio to Ferdinand VII.

Chronological Table of the Kings of Spain.

Year.	Asturias and Leon.	Castile.	Aragon.	Navarre.	Saracens.
718	Pelagius.				
737	Favila.				
739	Alphonso I.				
755	- - -	- - -	- - -	- - -	Abdoulrahman I.
758	Froila I.				
768	Aurelio.				
774	Silo.				
783	Mauregat.				
788	Bermudo I.	- - -	- - -	- - -	Hissem.
791	Alphonso II.				
795	- - -	- - -	- - -	- - -	Hachem.
822	- - -	- - -	- - -	- - -	Abdoulrahman II.
845	Ramiro I.				
851	Ordogno I.	- - -	- - -	Garcias Ximenes.	
853	- - -	- - -	- - -	- - -	Mahomet.
862	Alphonso III.				
880	- - -	- - -	- - -	Fortunio I.	
886	- - -	- - -	- - -	- - -	Almundar.
888	- - -	- - -	- - -	- - -	Abdallah.
905	- - -	- - -	- - -	Sancho I.	
910	Garcias.				
912	- - -	- - -	- - -	- - -	Abdoulrahman III.
913	Ordogno II.				
923	Froila II.				
924	Alphonso IV.				
926	- - -	- - -	- - -	Garcias II.	
927	Ramiro II.				
950	Ordogno III.				
956	Sancho.				
961	- - -	- - -	- - -	- - -	Alhacan.
967	Ramiro III.				
976	- - -	- - -	- - -	- - -	Hissem.
978	- - -	- - -	- - -	Sancho II.	
982	Bermudo II.				
994	- - -	- - -	- - -	Garcias III.	
999	Alphonso V.				
1000	- - -	- - -	- - -	Sancho III.	
1014	- - -	- - -	- - -	- -	Cordova overthrown
1027	Bermudo III.				
1035	- - -	- - -	Ramiro I.	Garcias IV.	
1037	Sancho I. Ferdinand I. of Castile.	Ferdinand I.			
1054	- - -	- - -	- - -	Sancho IV.	
1063	- - -	- - -	Sancho.		
1067	Sancho II.	Sancho I.			
1073	Alphonso VI.	Alphonso I.			
1076	- - -	- - -	- - -	Sancho V.	
1094	- - -	- - -	Pedro I.	Pedro I.	
1104	- - -	- - -	Alphonso I.	Alphonso I.	
1109	Urraca.	Alphonso II.			
1112	Alphonso VII.				

Year.	*Asturias and Leon.*	*Castile.*	*Aragon.*	*Navarre.*	*Saracens.*
1126	Alphonso VIII.	Alphonso III.			
1134	- - -	- - -	Ramiro II.	Garcias V.	
1137	- - -	- - -	Petronilla.		
1150	- - -	- - -	- - -	Sancho VI.	
1157	Ferdinand II.	Sancho II.			
1158	- - -	Alphonso IV.			
1162	- - -	- - -	Alphonso II.		
1188	Alphonso IX.				
1194	- - -	- - -	- - -	Sancho VII.	
1196	- - -	- - -	Pedro II.		
1213	- - -	- - -	James I.		
1214	- - -	Henry.			
1217	- - -	Berenger. Ferd. I.			
1234	- - -	- - -	- - -	Thibaut I.	
1236	- - -	- - -	- - -	- - -	Mahomet.
1252	- - -	Alphonso V. -			
1253	- - -	- - -		Thibaut II.	
1270	- - -	- - -	- - -	Henry.	
1273	- - -	- - -	- - -	- - -	Muley.
1274	- - -	- - -	- - -	Joanna.	
1276	- - -	- - -	Pedro III.		
1284	- - -	Sancho III.			
1285	- - -	- - -	Alphonso III.		
1291	- - -	- - -	James II.		
1295	- - -	Ferdinand II.			
1302	- - -	- - -	- - -	- - -	Mahomet II.
1304	- - -	- - -	- - -	Lewis.	
1310	- - -	- - -	- - -	- -	Nazer.
1312	- - -	Alphonso VI.			
1315	- - -	- - -	- - -	- - -	Ismael.
1316	- - -	- - -	- - -	Philip.	
1322	- - -	- - -	- - -	Charles.	
1326	- - -	- - -	- - -	- - -	Mahomet III.
1327	- - -	- - -	Alphonso IV.		
1328	- - -	- - -	- - -	Joanna II.	
1333	- - -	- - -	- - -	- - -	Juzaf I.
1336	- - -	- - -	Pedro IV.		
1349	- - -	- - -	- - -	Charles II.	
1350	- - -	Pedro.			
1354	- - -	- - -	- - -	- - -	Lago I.
1369	- - -	Henry II.			
1374	- - -	- - -	- - -	- - -	Mahomet IV.
1379	- - -	John.	- - -	- - -	Mahomet V.
1387	- - -	- - -	- - -	Charles III.	
1390	- - -	Henry III.			
1392	- - -	- - -	- - -	- - -	Juzaf II.
1395	- - -	- - -	Martin.		
1396	- - -	- - -	- - -	- - -	Balba.
1404	- - -	John II.			
1408	- - -	- - -	- - -	- - -	Juzaf III.
1412	- - -	- - -	Ferdinand I.		
1416	- - -	- - -	Alphonso V.	- - -	Elaziri.
1423	- - -	- - -	- - -		
1425	- - -	- - -	- - -	Blanche.	
1427	- - -	- - -	- - -	- - -	Zagair.
1432	- - -	- - -	- - -	- - -	Juzaf IV.
1441	- - -	- - -	- - -	John.	
1445	- - -	- - -	- - -	- - -	Ben Osmin.

Spain.

Year.	Aſturias and Leon.	Caſtile.	Aragon.	Navarre.	Saracens.
1450	- - -	Henry IV.			
1453	- - -	- -	- - -	- - -	Iſmael.
1458	- - -	- -	John II.		
1459	- - -	- -	Ferdinand II.		
1474	- - -	Iſabella and Ferdinand V.			
1475	- - -	- - -	- - -	Eleonora.	Abilhuſſan.
1479	- - -	- - -	- - -	Francis.	
1483	- - -	- - -	- - -	Catherine.	
1485	- - -	- - -	- - -	John.	Abouabdalla.
1504	- - -	Joan.			
1506	- - -	Philip I.			
1516	- - -	Charles I.	- - -	Henry.	
1553	- - -	- - -	- - -	Joanna III.	
1556	- - -	Philip II.	- - -	Anthony.	
1572	- - -	- - -	- - -	Henry.	
1598	- - -	Philip III.			

Kings of Spain.

Years.	Monarchs.
	House of Austria.
1516	Charles I. (V.).
1556	Philip II.
1598	Philip III.
1621	Philip IV.
1665	Charles II.
	House of Bourbon.
1700	Philip V.
1723	Louis I.
1724	Philip V. again.
1746	Ferdinand VI.
1759	Charles III.
1788	Charles IV.
1808	Ferdinand VII.

An. 737. Don Pelagio died in 737; and ſoon after his death ſuch inteſtine diviſions broke out among the Moors, as greatly favoured the increaſe of the Chriſtian power. In 745 Don Alonſo the Catholic, ſon-in-law to Pelagio, in conjunction with his brother Froila, paſſed the mountains, and fell upon the northern part of Gallicia; and meeting with little reſiſtance, he recovered almoſt the whole of that province in a ſingle campaign. Next year he invaded the plains of Leon and Caſtile; and before the Moors could aſſemble any force to oppoſe him, he reduced Aſtorgas, Leon, Saldagna, Montes de Oca, Amaya, Alava, and all the country at the foot of the mountains. The year following he puſhed his conqueſts as far as the borders of Portugal, and the next campaign ravaged the country as far as Caſtile. Being ſenſible, however, that he was yet unable to defend the flat country which he had conquered, he laid the whole of it waſte, obliged the Chriſtians to retire to the mountains, and carried off all the Moors for ſlaves. Thus ſecured by a deſert frontier, he met with no interruption for ſome years; during which time, as his kingdom advanced in ſtrength, he allowed his ſubjects gradually to occupy part of the flat country, and to rebuild Leon and Aſtorgas, which he had demoliſhed. He died in 758, and was ſucceeded by his ſon Don Froila. In his time Abdoulrahman, the khaliff's viceroy in Spain, threw off the yoke, and rendered himſelf independent, fixing the ſeat of his government at Cordova. Thus the inteſtine diviſions among the Moors were compoſed; yet their ſucceſs ſeems to have been little better than before; for, ſoon after, Froila encountered the Moors with ſuch ſucceſs, that 54,000 of them were killed on the ſpot, and their general taken priſoner. Soon after he built the city of Oviedo, which he made the

55 Conqueſts of the Chriſtians. An. 745.

56 The Saracens in Spain throw off the yoke of the khalifs. An. 758.

the capital of his dominions, in order to be in a better condition to defend the flat country, which he now determined to people.

57
Hiftory of the kingdom of Navarre.
An. 850.

In the year 850 the power of the Saracens received another blow by the rife of the kingdom of Navarre. This kingdom, we are told, took its origin from an accidental meeting of gentlemen, to the number of 600, at the tomb of an hermit named *John*, who had died among the Pyrenees. At this place, where they had met on account of the fuppofed fanctity of the deceafed, they took occafion to converfe on the cruelty of the Moors, the miferies to which the country was expofed, and the glory that would refult from throwing off their yoke; which, they fuppofed, might eafily be done, by reafon of the ftrength of their country. On mature deliberation, the project was approved; one Don Garcias Ximenes was appointed king, as being of illuftrious birth, and looked upon as a perfon of great abilities. He recovered Ainfa, one of the principal towns of the country, out of the hands of the infidels, and his fucceffor Don Garcias Inigas extended his territories as far as Bifcay; however, the Moors ftill poffeffed Portugal, Murcia, Andalufia, Valeneia, Granada, Tortofa, with the interior part of the country as far as the mountains of Caftile and Zaragoza. Their internal diffenfions, which revived after the death of Abdoulrahman, contributed greatly to reduce the power of the infidels in general.

58
Conquefts of Charles the Great.

In 778, Charles the Great being invited by fome difcontented Moorifh governors, entered Spain with two great armies; one paffing through Catalonia, and the other through Navarre, where he pufhed his conquefts as far as the Ebro. On his return he was attacked and defeated by the Moors; though this did not hinder him from keeping poffeffion of all thofe places he had already reduced. At this time he feems to have been mafter of Navarre: however, in 831 Count Azner, revolting from Pepin fon to the emperor Louis, afferted the independency of Navarre; but the fovereigns did not affume the title of kings till the time of Don Garcias, who began to reign in 857.

An. 921.

In the mean time, the kingdom founded by Don Pelagio, now called the kingdom of *Leon* and *Oviedo*, continued to increafe rapidly in ftrength, and many advantages were gained over the Moors, who having two enemies to contend with, loft ground every day. In 921, however, they gained a great victory over the united forces of Navarre and Leon, by which the whole force of the Chriftians in Spain muft have been entirely broken, had not the victors conducted their affairs fo wretchedly, that they fuffered themfelves to be almoft entirely cut in pieces by the remains of the Chriftian army. In fhort, the Chriftians became at length fo terrible to the Moors, that it is probable they could not long have kept their footing in Spain, had not a great general, named *Mohammed Ebn Amir Almanzor*, appeared, in 979, to fupport their finking caufe.

59
Exploits of Almanzor a Saracen general.
An. 979

This man was vifir to the king of Cordova, and being exceedingly provoked againft the Chriftians on account of what his countrymen had fuffered from them, made war with the moft implacable fury. He took the city of Leon, murdered the inhabitants, and reduced the houfes to afhes. Barcelona fhared the fame fate; Caftile was reduced to a defert; Galicia and Portugal ravaged; and he is faid to have overcome the Chriftians in fifty different engagements. At laft, having taken and demolifhed the city of Compoftella, and carried off in triumph the gates of the church of St James, a flux happened to break out among his troops, which the fuperftitious Chriftians fuppofed to be a divine judgement on account of his facrilege. Taking it for granted, therefore, that the Moors were now entirely deftitute of all heavenly aid, they fell upon them with fuch fury in the next engagement, that all the valour and conduct of Almanzor could not prevent a defeat. Overcome with fhame and defpair at this misfortune, he defired his followers to fhift for themfelves, while he himfelf retired to Medina Cœli, and put an end to his life by abftinence in the year 998.

60
He is defeated, and ftarves himfelf to death.
An. 998.

61
Rife of the kingdom of Caftile.
An. 1037.

During this period a new Chriftian principality appeared in Spain, namely that of Caftile, which is now divided into the Old and New Caftile. The Old Caftile was recovered long before that called the *New*. It was feparated from the kingdom of Leon on one fide by fome little rivers; on the other, it was bounded by the Afturias, Bifcay, and the province of Rioja. On the fouth it had the mountains of Segovia and Avila; thus lying in the middle between the Chriftian kingdom of Leon and Oviedo, and the Moorifh kingdom of Cordova. Hence this diftrict foon became an object of contention between the kings of Leon and thofe of Cordova; and as the former were generally victorious, fome of the principal Caftilian nobility retained their independence under the protection of the Chriftian kings, even when the power of the Moors was at its greateft height. In 884 we firft hear of Don Rodriguez affuming the title of *count of Caftile*, though it does not appear that either his territory or title were given him by the king of Leon. Neverthelefs, this monarch having taken upon him to punifh fome of the Caftilian lords as rebels, the inhabitants made a formal renunciation of their allegiance, and fet up a new kind of government. The fupreme power was now vefted in two perfons of quality ftyled *judges*; however, this method did not long continue to give fatisfaction, and the fovereignty was once more vefted in a fingle perfon. By degrees Caftile fell entirely under the power of the kings of Leon and Oviedo; and, in 1037, Don Sancho beftowed it on his eldeft fon Don Ferdinand, with the title of *king*; and thus the territories of Caftile were firft firmly united to thofe of Leon and Oviedo, and the fovereigns were thenceforth ftyled *kings of Leon and Caftile*.

62
Rife of Aragon.
An. 1035.

Befides all thefe, another Chriftian kingdom was fet up in Spain about the beginning of the 11th century. This was the kingdom of Aragon. The inhabitants were very brave, and lovers of liberty, fo that it is probable they had in fome degree maintained their independence, even when the power of the Moors was greateft. The hiftory of Aragon, however, during its infancy, is much lefs known than that of any of the others hitherto mentioned.

63
State of Spain in the beginning of the 11th century.

We are only affured, that about the year 1035, Don Sancho, furnamed the *Great*, king of Navarre, erected Aragon into a kingdom in favour of his fon Don Ramiro, and afterwards it became very powerful. At this time, then, we may imagine the continent of Spain divided into two unequal parts by a ftraight line drawn from eaft to weft, from the coafts of Valencia to a little below the mouth of the Douro. The country north of this belonged to the Chriftians, who, as yet, had the fmalleft and leaft valu-

able

Spain.

able ſhare, and all the reſt to the Moors. In point of wealth and real power, both by land and ſea, the Moors were much ſuperior; but their continual diſſenſions greatly weakened them, and every day facilitated the progreſs of the Chriſtians. Indeed, had either of the parties been united, the other muſt ſoon have yielded; for though the Chriſtians did not make war upon each other conſtantly as the Moors did, their mutual feuds were yet ſufficient to have ruined them, had their adverſaries made the proper uſe of the advantages thus afforded them. But among the Moors almoſt every city was a kingdom; and as theſe petty ſovereignties ſupported one another very indifferently, they fell a prey one after another to their enemies. In 1080, the king of Toledo was engaged in a war with the king of Seville, another Mooriſh potentate; which being obſerved by Alphonſo king of Caſtile, he alſo invaded his territories; and in four years made himſelf maſter of the city of Toledo, with all the places of importance in its neighbourhood; from thenceforth making Toledo the capital of his dominions. In a ſhort time the whole province of New Caſtile ſubmitted; and Madrid, the preſent capital of Spain, fell into the hands of the Chriſtians, being at that time but a ſmall place.

64 Toledo and Madrid taken by the Chriſtians. An. 1080.

The Moors were ſo much alarmed at theſe conqueſts, that they not only entered into a general confederacy againſt the Chriſtians, but invited to their aſſiſtance Mahomet Ben Joſeph the ſovereign of Barbary. He accordingly came, attended by an incredible multitude; but was utterly defeated by the Chriſtians in the defiles of the Black Mountain, or Sierra Morena, on the borders of Andaluſia. This victory happened on the 16th of July 1212, and the anniverſary is ſtill celebrated at Toledo. This victory was not improved; the Chriſtian army immediately diſperſed themſelves, while the Moors of Andaluſia were ſtrengthened by the remains of the African army; yet, inſtead of being taught, by their paſt misfortunes, to unite among themſelves, their diſſenſions became worſe than ever, and the conqueſts of the Chriſtians became daily more rapid. In 1236, Don Ferdinand of Caſtile and Leon took the celebrated city of Cordova, the reſidence of the firſt Mooriſh kings; at the ſame time that James I. of Aragon diſpoſſeſſed them of the iſland of Majorca, and drove them out of Valencia. Two years after, Ferdinand made himſelf maſter of Murcia, and took the city of Seville; and in 1303 Ferdinand IV reduced Gibraltar.

65 A ſignal victory gained over the Moors. An. 1212.

An. 1236.

66 England interferes in the Spaniſh affairs.

In the time of Edward III. we find England, for the firſt time, interfering in the affairs of Spain, on the following occaſion. In the year 1284 the kingdom of Navarre had been united to that of France by the marriage of Donna Joanna queen of Navarre with Philip the Fair of France. In 1328, however, the kingdoms were again ſeparated, though the ſovereigns of Navarre were ſtill related to thoſe of France. In 1350, Charles, ſurnamed the *Wicked*, aſcended the throne of Navarre, and married the daughter of John king of France. Notwithſtanding this alliance, and that he himſelf was related to the royal family of France, he ſecretly entered into a negociation with England againſt the French monarch, and even drew into his ſchemes the dauphin Charles, afterwards ſurnamed *the Wiſe*. The young prince, however, was ſoon after made fully ſenſible of the danger and folly of the connections into which he had entered; and, by way of atonement, promiſed to ſacrifice his aſſociates. Accordingly he invited the king of Navarre, and ſome of the principal nobility of the ſame party, to a feaſt at Rouen, where he betrayed them to his father. The moſt obnoxious were executed, and the king of Navarre was thrown into priſon. In this extremity, the party of the king of Navarre had recourſe to England. The prince of Wales, ſurnamed *the Black Prince*, invaded France, defeated King John at Poictiers, and took him priſoner *; which unfortunate event produced the moſt violent diſturbances in that kingdom. The dauphin, now about 19 years of age, naturally aſſumed the royal power during his father's captivity: but poſſeſſed neither experience nor authority ſufficient to remedy the prevailing evils. In order to obtain ſupplies, he aſſembled the ſtates of the kingdom: but that aſſembly, inſtead of ſupporting his adminiſtration, laid hold of the preſent opportunity to demand limitations of the prince's power, the puniſhment of paſt malverſations, and the liberty of the king of Navarre. Marcel, provoſt of the merchants of Paris, and firſt magiſtrate of that city, put himſelf at the head of the unruly populace, and puſhed them to commit the moſt criminal outrages againſt the royal authority. They detained the dauphin in a kind of captivity, murdered in his preſence Robert de Clermont and John de Conflans, mareſchals of France; threatened all the other miniſters with the like fate; and when Charles, who had been obliged to temporize and diſſemble, made his eſcape from their hands, they levied war againſt him, and openly rebelled. The other cities of the kingdom, in imitation of the capital, ſhook off the dauphin's authority, took the government into their own hands, and ſpread the contagion into every province,

67 The king of Navarre impriſoned by John king of France.

* See France, N° 44.

68 Eſcapes, and heads the French malecontents.

Amidſt theſe diſorders, the king of Navarre made his eſcape from priſon, and preſented a dangerous leader to the furious malecontents. He revived his pretenſions to the crown of France: but in all his operations he acted more like a leader of banditti than one who aſpired to be the head of a regular government, and who was engaged by his ſtation to endeavour the re-eſtabliſhment of order in the community. All the French, therefore, who wiſhed to reſtore peace to their country, turned their eyes towards the dauphin; who, though not remarkable for his military talents, daily gained by his prudence and vigilance the aſcendant over his enemies. Marcel, the ſeditious provoſt of Paris, was ſlain in attempting to deliver that city to the king of Navarre. The capital immediately returned to its duty: the moſt conſiderable bodies of the mutinous peaſants were diſperſed or put to the ſword; ſome bands of military robbers underwent the ſame fate; and France began once more to aſſume the appearance of civil government.

John was ſucceeded in the throne of France by his ſon Charles V a prince educated in the ſchool of adverſity, and well qualified, by his prudence and experience, to repair the loſſes which the kingdom had ſuſtained from the errors of his predeceſſors. Contrary to the practice of all the great princes of thoſe times, who held nothing in eſtimation but military courage, he ſeems to have laid it down as a maxim, never to appear at the head of his armies; and he was the firſt European monarch that ſhowed the advantage of policy and foreſight over a raſh and precipitate valour.

Before Charles could think of counterbalancing ſo great

Spain.

69 Is defeated and obliged to submit to the terms prescribed by Charles V. of France.

great a power as England, it was necessary for him to remedy the many disorders to which his own kingdom was exposed. He accordingly turned his arms against the king of Navarre, the great disturber of France during that age; and he defeated that prince, and reduced him to terms, by the valour and conduct of Bertrand du Guesclin, one of the most accomplished captains of those times, whom Charles had the discernment to choose as the instrument of his victories. He also settled the affairs of Britanny, by acknowledging the title of Mountfort, and receiving homage for his dominions. But much was yet to be done. On the conclusion of the peace of Bretigni, the many military adventurers who had followed the fortunes of Edward, being dispersed into the several provinces, and possessed of strong holds, refused to lay down their arms, or relinquish a course of life to which they were now accustomed, and by which alone they could earn a subsistence.

70 Account of the banditti called *companies* or *companions*.

They associated themselves with the banditti, who were already inured to the habits of rapine and violence; and, under the name of *companies* and *companions*, became a terror to all the peaceable inhabitants. Some English and Gascon gentlemen of character were not ashamed to take the command of these ruffians, whose number amounted to near 40,000, and who bore the appearance of regular armies rather than bands of robbers. As Charles was not able by power to redress so enormous a grievance, he was led by necessity, as well as by the turn of his character, to correct it by policy; to discover some method of discharging into foreign countries this dangerous and intestine evil; and an occasion now offered.

71 Reign of Pedro the Cruel, king of Castile.

Alphonso XI. king of Castile, who took the city of Algezira from the Moors, after a famous siege of two years, during which artillery are said first to have been used by the besieged, had been succeeded by his son Pedro I. surnamed *the Cruel*; a prince equally perfidious, debauched, and bloody. He began his reign with the murder of his father's mistress, Leonora de Gusman: his nobles fell every day the victims of his severity: he put to death his cousin and one of his natural brothers, from groundless jealousy; and he caused his queen Blanche de Bourbon, of the blood of France, to be thrown into prison, and afterwards poisoned, that he might enjoy in quiet the embraces of Mary de Padella, with whom he was violently enamoured.

72 The Companies employed against him.

Henry count of Trastamara, the king's natural brother, alarmed at the fate of his family, and dreading his own, took arms against the tyrant; but having failed in the attempt, he fled to France, where he found the minds of men much inflamed against Pedro, on account of the murder of the French princess. He asked permission of Charles to enlist the *companies* in his service, and to lead them into Castile against his brother. The French king, charmed with the project, employed du Guesclin in negociating with the leaders of these banditti. The treaty was soon concluded; and du Guesclin having completed his levies, led the army first to Avignon, where the pope then resided, and demanded, sword in hand, absolution for his ruffian soldiers, who had been excommunicated, and the sum of 200,000 livres for their subsistence. The first was readily promised him, but some difficulty being made with regard to the second, du Guesclin replied, "My fellows, I believe, may make a shift to do without your absolution, but the money is absolutely necessary." His holiness then extorted from the inhabitants of the city and its neighbourhood the sum of 100,000 livres, and offered it to du Guesclin. "It is not my purpose (cried that generous warrior) to oppress the innocent people. The pope and his cardinals can spare me double the sum from their own pockets. I therefore insist, that this money be restored to the owners; and if I hear they are defrauded of it, I will myself return from the other side of the Pyrenees, and oblige you to make them restitution." The pope found the necessity of submitting, and paid from his own treasury the sum demanded.

73 He is driven out, but assisted by the Black Prince.

A body of experienced and hardy soldiers, conducted by so able a general, easily prevailed over the king of Castile, whose subjects were ready to join the enemy against their oppressor. Pedro fled from his dominions, took shelter in Guienne, and craved the protection of the prince of Wales, whom his father had invested with the sovereignty of the ceded provinces, under the title of the *principality of Aquitaine*. The prince promised his assistance to the dethroned monarch; and having obtained his father's consent, he levied an army, and set out on his enterprise.

The first loss which Henry of Trastamara suffered from the interposition of the prince of Wales, was the recalling of the companies from his service; and so much reverence did they pay to the name of Edward, that great numbers of them immediately withdrew from Spain, and enlisted under his standard. Henry, however, beloved by his new subjects, and supported by the king of Arragon, was able to meet the enemy with an army of 100,000 men, three times the number of those commanded by the Black Prince: yet du Guesclin, and all his experienced officers, advised him to delay a decisive action; so high was their opinion of the valour and conduct of the English hero! But Henry, trusting to his numbers, ventured to give Edward battle on the banks of the Ebro, between Najara and Navarette;

74 The Spaniards defeated, and Peter restored.

where the French and Spaniards were defeated, with the loss of above 20,000 men, and du Guesclin and other officers of distinction taken prisoners. All Castile submitted to the victor; Pedro was restored to the throne, and Edward returned to Guienne with his usual glory; having not only overcome the greatest general of his age, but restrained the most blood-thirsty tyrant from executing vengeance on his prisoners.

This gallant warrior had soon reason to repent of his connection with a man like Pedro, lost to all sense of virtue and honour. The ungrateful monster refused the stipulated pay to the English forces. Edward abandoned him: he treated his subjects with the utmost barbarity; their animosity was roused against him; and du Guesclin having obtained his ransom, returned to Castile with the count of Trastamara, and some forces levied anew in France. They were joined by the Spanish malecontents; and having no longer the Black Prince

75 Is again driven out, defeated, and put to death.

to encounter, they gained a complete victory over Pedro in the neighbourhood of Toledo. The tyrant now took refuge in a castle, where he was soon after besieged by the victors, and taken prisoner in endeavouring to make his escape. He was conducted to his brother Henry; against whom he is said to have rushed in a transport of rage, disarmed as he was. Henry slew him with his own

own hand, in resentment of his cruelties; and, though a bastard, was placed on the throne of Castile, which he transmitted to his posterity.

There is little doubt that the character of Pedro has been greatly misrepresented, and that what is considered by most historians as tyranny and wanton cruelty, was only an inflexible regard to justice, necessary perhaps, in those days of anarchy and rebellion. Perhaps that unfortunate monarch owes to the hatred of those he meant to reduce to order, much of the obloquy which has been so plentifully bestowed upon him by historians, who have painted him to us as a tyrant so bloody, so wicked, as almost to exceed the bounds of probability. In Andalusia, where he fixed his residence and seemed most to delight, his memory is not held in the same abhorrence. The Sevillian writers speak of him very differently; and instead of his usual appellation of *Pedro el cruel*, distinguish him by that of *el justiciero*. It is certain that his bastard-brother and murderer, Henry of Trastamara, was guilty of crimes fully as atrocious as any of those imputed to Don Pedro; but as he destroyed him, his family, and adherents, the friends of the new spurious race of monarchs were left at full liberty to blacken the characters of the adverse party, without the fear of being called to an account for calumny, or even contradicted. Truth is now out of our reach; and for want of proper proofs to the contrary, we must sit down contented with what history has left us; and allow Don Pedro to have been one of the most inhuman butchers that ever disgraced a throne.

After the death of Pedro the Cruel, nothing remarkable happened in Spain for almost a whole century; but the debaucheries of Henry IV. of Castile roused the resentment of his nobles, and produced a most singular insurrection, which led to the aggrandizement of the Spanish monarchy.

76
Reign of Henry the Impotent. An. 1450.

This prince, surnamed the *Impotent*, though continually surrounded with women, began his unhappy reign in 1450. He was totally enervated by his pleasures; and every thing in his court conspired to set the Castilians an example of the most abject flattery and most abandoned licentiousness. The queen, a daughter of Portugal, lived as openly with her parasites and her gallants as the king did with his minions and his mistresses. Pleasure was the only object, and effeminacy the only recommendation to favour: the affairs of the state went every day into disorder; till the nobility, with the archbishop of Toledo at their head, combining against the weak and flagitious administration of Henry, arrogated to themselves, as one of the privileges of their order, the right of trying and passing sentence on their sovereign, which they executed in a manner unprecedented in history.

77
He is formally deposed.

All the malecontent nobility were summoned to meet at Avila: a spacious theatre was erected in a plain without the walls of the town: an image, representing the king, was seated on a throne, clad in royal robes, with a crown on its head, a sceptre in its hand, and the sword of justice by its side. The accusation against Henry was read, and the sentence of deposition pronounced, in presence of a numerous assembly. At the close of the first article of the charge, the archbishop of Toledo advanced, and tore the crown from the head of the image; at the close of the second, the Conde de Placentia snatched the sword of justice from its side; at the close of the third, the Conde de Benavente wrested the sceptre from its hand; and at the close of the last, Don Diego Lopez de Stuniga tumbled it headlong from the throne. At the same instant, Don Alphonso, Henry's brother, a boy of about twelve years of age, was proclaimed king of Castile and Leon in his stead.

This extraordinary proceeding was followed by a civil war, which did not cease till some time after the death of the young prince, on whom the nobles had bestowed the kingdom. The archbishop and his party then continued to carry on war in the name of Isabella the king's sister, to whom they gave the title of *Infanta*; and Henry could not extricate himself out of these troubles, nor remain quiet upon his throne till he had signed one of the most humiliating treaties ever extorted from a sovereign; he acknowledged his sister Isabella the only lawful heiress of his kingdom, in prejudice to the rights of his reputed daughter Joan, whom the malecontents affirmed to be the offspring of an adulterous commerce between the queen and Don la Cueva.

78
Is obliged to acknowledge his sister Isabella to be heiress to the kingdom.

The grand object of the malecontent party now was the marriage of the princess Isabella, upon which, it was evident, the security of the crown and the happiness of the people must in a great measure depend. The alliance was sought by several princes: the king of Portugal offered her his hand; the king of France demanded her for his brother, and the king of Aragon for his son Ferdinand. The malecontents very wisely preferred the Aragonian prince, and Isabella prudently made the same choice: articles were drawn up; and they were privately married by the archbishop of Toledo.

79
She is married to Ferdinand of Aragon.

Henry was enraged at this alliance, which he foresaw would utterly ruin his authority, by furnishing his rebellious subjects with the support of a powerful neighbouring prince. He disinherited his sister, and established the rights of his daughter. A furious civil war desolated the kingdom. The names of Joan and Isabella resounded from every quarter, and were everywhere the summons to arms. But peace was at length brought about. Henry was reconciled to his sister and Ferdinand; though it does not appear that he ever renewed Isabella's right to the succession: for he affirmed in his last moments, that he believed Joan to be his own daughter. The queen swore to the same effect; and Henry left a testamentary deed, transmitting the crown to this princess, who was proclaimed queen of Castile at Placentia. But the superior fortune and superior arms of Ferdinand and Isabella prevailed: the king of Portugal was obliged to abandon his niece and intended bride, after many ineffectual struggles, and several years of war. Joan retired into a convent; and the death of Ferdinand's father, which happened about this time, added the kingdoms of Aragon and Sicily to those of Leon and Castile.

80
Union of the kingdoms of Aragon and Sicily with Leon and Castile. An. 1474.

81
Administration of Ferdinand and Isabella.

Ferdinand and Isabella were persons of great prudence, and, as sovereigns, highly worthy of imitation: but they do not seem to have merited all the praises bestowed upon them by the Spanish historians. They did not live like man and wife, having all things in common under the direction of the husband; but like two princes in close alliance; they neither loved nor hated each other; were seldom in company together, had each a separate council; and were frequently jealous of one another in the administration. But they

were

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were inseparably united in their common interests; always acting upon the same principles, and forwarding the same ends. Their first object was the regulation of their government, which the civil wars had thrown into the greatest disorder. Rapine, outrage, and murder, were become so common, as not only to interrupt commerce, but in a great measure to suspend all intercourse between one place and another. These evils the joint sovereigns suppressed by their wise policy, at the same time that they extended the royal prerogative.

82 Institution of the Holy Brotherhood,

About the middle of the 13th century, the cities in the kingdom of Aragon, and after their example those in Castile, had formed themselves into an association, distinguished by the name of the *Holy Brotherhood.* They exacted a certain contribution from each of the associated towns; they levied a considerable body of troops in order to protect travellers and pursue criminals; and they appointed judges, who opened courts in various parts of the kingdom. Whoever was guilty of murder, robbery, or any act that violated the public peace, and was seized by the troops of the Brotherhood, was carried before their judges; who, without paying any regard to the exclusive jurisdiction which the lord of the place might claim, who was generally the author or abettor of the injustice, tried, and condemned the criminals. The nobles often murmured against the salutary institution; they complained of it as an encroachment on one of their most valuable privileges, and endeavoured to get it abolished. But Ferdinand and Isabella, sensible of the beneficial effects of the Brotherhood, not only in regard to the police of their kingdom, but in its tendency to abridge, and by degrees annihilate, the territorial jurisdiction of the nobility, countenanced the institution upon every occasion, and supported it with the whole force of royal authority; by which means the prompt and impartial administration of justice was restored, and with it tranquillity and order returned.

83 and of the Inquisition.

But at the same time that their Catholic majesties (for such was the title they now bore) were giving vigour to their civil government, and securing their subjects from violence and oppression, an intemperate zeal led them to establish an ecclesiastical tribunal, equally contrary to the natural rights of humanity and the mild spirit of the gospel. This was the court of inquisition; which decides upon the honour, fortune, and even the life, of the unhappy wretch who happens to fall under the suspicion of heresy, or a contempt of any thing prescribed by the church, without his knowing, being confronted with his accusers, or permitted either defence or appeal. Six thousand persons were burnt by order of this sanguinary tribunal within four years after the appointment of Torquemada, the first inquisitor-general; and upwards of 100,000 felt its fury. The same furious and blinded zeal which led to the depopulation of Spain, led also to its aggrandizement.

84 Conquest of Granada An. 1492.

The kingdom of Granada now alone remained of all the Mahometan possessions in Spain. Princes equally zealous and ambitious were naturally disposed to turn their eyes to that fertile territory, and to think of increasing their hereditary dominions, by expelling the enemies of Christianity, and extending its doctrines. Every thing conspired to favour their project: the Moorish kingdom was a prey to civil wars; when Ferdinand, having obtained the bull of Sixtus IV. authorizing a crusade, put himself at the head of his troops, and entered Granada. He continued the war with rapid success: Isabella attended him in several expeditions; and they were both in great danger at the siege of Malaga; an important city, which was defended with great courage, and taken in 1487. Baza was reduced in 1489, after the loss of 20,000 men. Gaudix and Almeria were delivered up to them by the Moorish king Alzagel, who had first dethroned his brother Alboacen, and afterwards been chased from his capital by his nephew Abdali. That prince engaged in the service of Ferdinand and Isabella; who, after reducing every other place of eminence, undertook the siege of Granada. Abdali made a gallant defence; but all communication with the country being cut off, and all hopes of relief at an end, he capitulated, after a siege of eight months, on condition that he should enjoy the revenue of certain places in the fertile mountains of Alpuxarras; that the inhabitants should retain the undisturbed possession of their houses, goods, and inheritances; the use of their laws, and the free exercise of their religion (B). Thus ended the empire of the Arabs in Spain, after it had continued about 800 years. They introduced the arts and sciences into Europe at a time when it was lost in darkness; they possessed many of the luxuries of life, when they were not even known among the neighbouring nations; and they seem to have given birth to that romantic gallantry which so eminently prevailed in the ages of chivalry, and which, blending itself with the veneration of the northern nations for the softer sex, still particularly distinguishes ancient from modern manners. But the Moors, notwithstanding these advantages, and the eulogies bestowed upon them by some writers, appear always to have been destitute of the essential qualities of a polished people, humanity, generosity, and mutual sympathy.

The overthrow of the last Moorish kingdom was soon followed by the expulsion of the Saracens from Spain. This expulsion did not entirely take place till the 17th century. Vast numbers of the Moors, indeed, oppressed by their conquerors, abandoned a country where they could not reside with comfort and with freedom. From the reign of Ferdinand of Castile, to that of Philip III. of Spain, more than 3,000,000 of those people quitted Spain, and carried with them, not only a great part of their acquired wealth, but that industry and love of labour which are the foundation of national prosperity.

85 Prosperous state of Spain under the Moorish dominion.

The state of Spain has never been so flourishing at any period of its civilization, as during the period when it was chiefly possessed by the Moors. The first Saracen invaders, and the twenty successive lieutenants of the caliphs of Damascus, were attended by a numerous train of civil and military followers, who preferred a distant

(B) The particulars of the conquest of Granada are involved in much obscurity. If we were to credit the narrative of Giles Perez, as related by Mr Swinburne, the circumstances which led to that conquest were of a most romantic nature. See Swinburne's Travels, Letter xxi.

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diſtant fortune to narrow circumſtances at home; the private and public intereſt was promoted by the eſtabliſhment of faithful colonies, and the cities of Spain were proud to commemorate the tribe or the country of their eaſtern progenitors. Ten years after the conqueſt, a map of the province was preſented to the caliph, ſhewing the ſeas, the rivers, and the harbours, the inhabitants and cities, the climate, the ſoil, and the mineral productions of the earth. In the ſpace of two centuries, the gifts of nature were improved by agriculture, the manufactures, and the commerce of an induſtrious people; though the effects of their diligence have been magnified by the idleneſs of their fancy. The firſt of the Ommiades who reigned in Spain ſolicited the ſupport of the Chriſtians; and in his edict of peace and protection, he contents himſelf with a modeſt impoſition of 10,000 ounces of gold, 10,000 pounds of ſilver, 10,000 horſes, as many mules, 1000 cuiraſſes, with an equal number of helmets and lances. The moſt powerful of his ſucceſſors derived from the ſame kingdom the annual tribute of 12,045,000 dinars or pieces of gold, about 6,000,000l. of ſterling money; a ſum which, in the 10th century, moſt probably ſurpaſſed the united revenues of the Chriſtian monarchs. His royal ſeat of Cordova contained 600 moſques, 900 baths, and 200,000 houſes; he gave laws to 80 cities of the firſt, to 300 of the ſecond and third order; and the fertile banks of the Guadalquivir were adorned with 12,000 villages and hamlets. The Arabs might exaggerate the truth; but they created and they deſcribe the moſt proſperous era of the riches, the cultivation, and the populouſneſs of Spain (c).

86
Jews expelled from Spain.

The conqueſt of Granada was followed by the expulſion, or rather the pillage and baniſhment, of the Jews, who had engroſſed all the wealth and commerce of Spain. The inquiſition exhauſted its rage againſt theſe unhappy people, many of whom pretended to embrace Chriſtianity, in order to preſerve their property. About the ſame time their Catholic majeſties concluded an alliance with the emperor Maximilian, and a treaty of marriage for their daughter Joan with his ſon Philip, archduke of Auſtria and ſovereign of the Netherlands. About this time alſo the contract was concluded with Chriſtopher Columbus for the diſcovery of new countries; and the counties of Rouſſillon and Cerdagne were agreed to be reſtored by Charles VIII. of France, before his expedition into Italy. The diſcovery of America was ſoon followed by extenſive conqueſts in that quarter, as is related under the articles Mexico, Peru, Chili, &c. which tended to raiſe the Spaniſh monarchy above any other in Europe.

87
Diſcovery of America, &c.

88
Acceſſion of Charles V. An. 1516.

On the death of Iſabella, which happened in 1506, Philip archduke of Auſtria came to Caſtile in order to take poſſeſſion of that kingdom as heir to his mother-in-law; but he dying in a ſhort time after, his ſon Charles V. afterwards emperor of Germany, became heir to the crown of Spain. His father at his death left the king of France governor to the young prince, and Ferdinand at his death left Cardinal Ximenes ſole regent of Caſtile, till the arrival of his grandſon. This man, whoſe character is no leſs ſingular than illuſtrious, who united the abilities of a great ſtateſman with the abject devotion of a ſuperſtitious monk, and the magnificence of a prime miniſter with the ſeverity of a mendicant, maintained order and tranquillity in Spain, notwithſtanding the diſcontents of a turbulent and high-ſpirited nobility. When they diſputed his right to the regency, he coolly ſhewed them the teſtament of Ferdinand, and the ratification of that deed by Charles; but theſe not ſatisfying them, and argument proving ineffectual, he led them inſenſibly towards a balcony, whence they had a view of a large body of troops under arms, and

(c) Abdoulrahman III. monarch of Cordova, ſurpaſſed all his predeceſſors in ſplendour, riches, and expence; and his ſubjects vied with each other in profuſion and magnificence. Some idea may be entertained of the opulence and grandeur of the Moors of Cordova in the 10th century, by peruſing the following enumeration of the preſents made to Abdoulrahman by Abumelik his grand vizir, on his appointment to that office. We are told that the miniſter cauſed to be brought before the throne, and laid at the feet of his maſter,

400 lbs. of virgin gold.
Ingots of ſilver to the value of 420,000 ſequins.
400 lbs. of lignum aloes, one piece weighing 140 lb.
500 oz. of ambergris.
300 oz. of camphor.
30 pieces of gold tiſſue, ſo rich that none but the caliph could wear it.
10 ſuits of Khoraſſan ſables.
100 ſuits of fur of a leſs valuable ſort.
48 ſets of gold and ſilk long trappings for horſes.
4000 lbs. of ſilk.
30 Perſian carpets.
800 iron coats-of-mail for war horſes.
1000 ſhields.
100,000 arrows.
15 led horſes of Arabia, as richly capariſoned as thoſe on which the caliph was wont to ride.
100 horſes of an inferior price.
20 mules with all their accoutrements.
40 young men, and 20 girls of exquiſite beauty, and moſt ſumptuouſly apparelled. This diſplay of riches was accompanied with a moſt flattering poem, compoſed by the miniſter in praiſe of his ſovereign, who in return for his homage, aſſigned him a penſion of 100,000 pieces of gold, about 50,000l. ſterling.

and a formidable train of artillery. "Behold (ſaid the cardinal) the powers which I have received from his Catholic majeſty: by theſe I govern Caſtile; and will govern it, till the king, your maſter and mine, ſhall come to take poſſeſſion of his kingdom." A declaration ſo bold and determined ſilenced all oppoſition; and Ximenes maintained his authority till the arrival of

89 Charles in 1517.

Diſgrace and death of Cardinal Ximenes.

The young king was received with univerſal acclamations of joy; but Ximenes found little cauſe to rejoice. He was ſeized with a violent diſorder, ſuppoſed to be the effect of poiſon; and when he recovered, Charles, prejudiced againſt him by the Spaniſh grandees and his Flemiſh courtiers, ſlighted his advice, and allowed him every day to ſink into neglect. The cardinal did not bear this treatment with his uſual fortitude of ſpirit. He 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 authority more extenſive and better eſtabliſhed than the moſt illuſtrious of his anceſtors had ever poſſeſſed. Conſcious of his own integrity and merit, he could not therefore refrain from giving vent, at times, to indignation and complaint. He lamented the fate of his country, and foretold the calamities to which it would be expoſed from the inſolence, the rapacioufneſs, and the ignorance of ſtrangers. But in the mean time he received a letter from the king, diſmiſſing him from his councils, under pretence of eaſing his age of that burden which he had ſo long and ſo ably ſuſtained. This letter proved fatal to the miniſter; for

90 he expired in a few hours after reading it.

Maximilian attempts to get Charles elected emperor.

While Charles was taking poſſeſſion of the throne of Spain, in conſequence of the death of one grandfather, another was endeavouring to obtain for him the imperial crown. With this view Maximilian aſſembled a diet at Augſburg, where he cultivated the favour of the electors by many acts of beneficence, in order to engage them to chooſe that young prince as his ſucceſſor. But Maximilian himſelf never having been crowned by the pope, a ceremony deemed eſſential in that age, as well as in the preceding, he was conſidered only as king of the Romans, or emperor elect; and no example occurring in hiſtory of any perſon being choſen ſucceſſor to a king of the Romans, the Germans, always tenacious of their forms, obſtinately refuſed to confer upon Charles a dignity for which their conſtitution knew no name.

But though Maximilian could not prevail upon the German electors to chooſe his grandſon of Spain king of the Romans, he had diſpoſed their minds in favour of that prince; and other circumſtances, on the death of the emperor, conſpired to the exaltation of Charles. The imperial crown had ſo long continued in the Auſtrian line, that it began to be conſidered as hereditary in that family; and Germany, torn by religious diſputes, ſtood in need of a powerful emperor, not only to preſerve its own internal tranquillity, but alſo to protect it againſt the victorious arms of the Turks, who under Selim I. threatened the liberties of Europe. This fierce and rapid conqueror had already ſubdued the Mamelukes, and made himſelf maſter of Egypt and Syria. The power of Charles appeared neceſſary to oppoſe that of Selim. The extenſive dominions of the houſe of Auſtria, which gave him an intereſt in the preſervation of Germany; the rich ſovereignty of the Netherlands and Franche Compté; the entire poſſeſſion of the great and warlike kingdom of Spain, together with that of Naples and Sicily, all united to hold him up to the firſt dignity among Chriſtian princes; and the new world ſeemed only to be called into exiſtence that its treaſures might enable him to defend Chriſtendom againſt the infidels. Such was the language of his partiſans.

91 Francis I. aſpires to the ſame dignity.

Francis I. however, no ſooner received intelligence of the death of Maximilian, than he declared himſelf a candidate for the empire; and with no leſs confidence of ſucceſs than Charles. He truſted to his ſuperior years and experience; his great reputation in arms; and it was farther urged in his favour, that the impetuoſity of the French cavalry, added to the firmneſs of the German infantry, would prove irreſiſtible, and not only be ſufficient, under a warlike emperor, to ſet limits to the ambition of Selim, but to break entirely the Ottoman power, and prevent it from ever becoming dangerous again to Germany.

Both claims were plauſible. The dominions of Francis were leſs extenſive, but more united than thoſe of Charles. His ſubjects were numerous, active, brave, lovers of glory, and lovers of their king. Theſe were ſtrong arguments in favour of his power, ſo neceſſary at this juncture: but he had no natural intereſt in the Germanic body; and the electors, hearing ſo much of military force on each ſide, became more alarmed for their own privileges than the common ſafety. They determined to reject both candidates, and offered the imperial crown to Frederic, ſurnamed the *Wiſe*, duke of Saxony. But he, undazzled by the ſplendour of an object courted with ſo much eagerneſs, by two mighty monarchs, rejected it with a magnanimity no leſs ſingular than great. 92

Speech of Frederic duke of Saxony in favour of Charles.

"In times of tranquillity (ſaid Frederic), we wiſh for an emperor who has no power to invade our liberties; times of danger demand one who is able to ſecure our ſafety. The Turkiſh armies, led by a warlike and victorious monarch, are now aſſembling: they are ready to pour in upon Germany with a violence unknown in former ages. New conjunctures call for new expedients. The imperial ſceptre muſt be committed to ſome hand more powerful than mine or that of any other German prince. We poſſeſs neither dominions, nor revenues, nor authority, which enable us to encounter ſuch a formidable enemy. Recourſe muſt be had, in this exigency, to one of the rival monarchs. Each of them can bring into the field forces ſufficient for our defence. But as the king of Spain is of German extraction, as he is a member and prince of the empire by the territories which deſcend to him from his grandfather, and as his dominions ſtretch along that frontier which lies moſt expoſed to the enemy, his claim, in my opinion, is preferable to that of a ſtranger to our language, to our blood, and to our country." Charles was elected in conſequence of this ſpeech in the year 1520. 93

He is elected in conſequence of this ſpeech. An. 1520.

The two candidates had hitherto conducted their rivalſhip with emulation, but without enmity. They had even mingled in their competition many expreſſions of friendſhip and regard. Francis in particular declared with his uſual vivacity, that his brother Charles and he were fairly and openly ſuitors to the ſame miſtreſs: "The moſt aſſiduous and fortunate (added he) will win her; and the other muſt reſt contented." But the preference was no ſooner given to his rival, than Francis diſcovered

Spain.

discovered all the passions natural to disappointed ambition. He could not suppress his chagrin and indignation at being baulked in his favourite pursuit, and rejected, in the face of all Europe, for a youth yet unknown to fame. The spirit of Charles resented such contempt; and from this jealousy, as much as from opposition of interests, arose that emulation between those two great monarchs which involved them in almost perpetual hostilities, and kept their whole age in constant agitation.

94 A mutual hatred takes place between Charles and Francis.

Charles and Francis had many interfering claims in Italy; and the latter thought himself bound in honour to restore the king of Navarre to his dominions, unjustly seized by the crown of Spain. They immediately began to negotiate; and as Henry VIII. of England was the third prince of the age in power and in dignity, his friendship was eagerly courted by each of the rivals. He was the natural guardian of the liberties of Europe. Sensible of the consequence which his situation gave him, and proud of his pre-eminence, Henry knew it to be his interest to keep the balance even between the contending powers, and to restrain both, by not joining entirely with either; but he was seldom able to reduce his ideas to practice. Vanity and resentment were the great springs of all his undertakings; and his neighbours, by touching these, found an easy way to draw him into their measures, and force him upon many rash and inconsiderate enterprises.

95 Both court the friendship of Henry VIII. of England.

All the impolitic steps in Henry's government must not, however, be imputed to himself; many of them were occasioned by the ambition and avarice of his prime minister and favourite Cardinal Wolsey. This man, who, by his talents and accomplishments, had risen from one of the lowest conditions in life to the highest employments both in church and state, enjoyed a greater degree of power and dignity than any English subject ever possessed, and governed the haughty, presumptuous, and untractable spirit of Henry, with absolute authority. Francis was equally well acquainted with the character of Henry and of his minister. He had successfully flattered Wolsey's pride, by honouring him with particular marks of his confidence, and bestowing upon him the appellations of *Father*, *Tutor*, and *Governor;* and he had obtained the restitution of Tournay, by adding a pension to those respectful titles. He now solicited an interview with the king of England near Calais; in hopes of being able, by familiar conversation, to attach him to his friendship and interest, while he gratified the cardinal's vanity, by affording him an opportunity of displaying his magnificence in the presence of two courts, and of discovering to the two nations his influence over their monarchs. Charles dreaded the effects of this projected interview between two gallant princes, whose hearts were no less susceptible of friendship than their manners were of inspiring it. Finding it impossible, however, to prevent a visit, in which the vanity of all parties was so much concerned, he endeavoured to defeat its purpose, and to pre-occupy the favour of the English monarch, and of his minister, by an act of complaisance still more flattering and more uncommon. Relying wholly upon Henry's generosity for his safety, he landed at Dover, in his way from Spain to the Low Countries. The king of England, who was on his way to France, charmed with such an instance of confidence, hastened to receive his royal guest;

96 An interview projected between Francis and Henry.

97 Charles visits Henry in England.

and Charles, during his short stay, had the address not only to give Henry favourable impressions of his character and intentions, but to detach Wolsey entirely from the interest of Francis. The tiara had attracted the eye of that ambitious prelate; and as the emperor knew that the papacy was the sole point of elevation, beyond his present greatness, at which he could aspire, he made him an offer of his interest on the first vacancy.

98 Henry visits Francis in France.

The day of Charles's departure, Henry went over to Calais with his whole court, in order to meet Francis. Their interview was in an open plain between Guisnes and Ardres; where the two kings and their attendants displayed their magnificence with such emulation and profuse expence, as procured it the name of the *Field of the Cloth of Gold.* Here Henry erected a spacious house of wood and canvas, framed in London, on which, under the figure of an English archer, was the following motto, "He prevails whom I favour;" alluding to his own political situation, as holding in his hands the balance of power among the potentates of Europe. Feats of chivalry however, parties of gallantry, and such exercises as were in that age reckoned manly or elegant, rather than serious business, occupied the two courts during the time that they continued together, which was 18 days.

After taking leave of this scene of dissipation, the king of England paid a visit to the emperor and Margaret of Savoy at Gravelines, and engaged them to go along with him to Calais; where the artful and politic Charles completed the impression which he had begun to make on Henry and his favourite, and effaced all the friendship to which the frank and generous nature of Francis had given birth. He renewed his assurances of assisting Wolsey in obtaining the papacy; and he put him in present possession of the revenues belonging to the sees of Badajoz and Palencia in Spain. He flattered Henry's pride, by convincing him of his own importance, and of the justness of the motto which he had chosen; offering to submit to his sole arbitration any difference that might arise between him and Francis.

99 Charles invested with the imperial crown at Aix-la-Chapelle.

This important point being secured, Charles repaired to Aix-la-Chapelle, where he was solemnly invested with the crown and sceptre of Charlemagne, in presence of a more splendid and numerous assembly than had appeared on any former inauguration. About the same time Solyman the Magnificent, one of the most accomplished, enterprising, and victorious of the Turkish princes, and a constant and formidable rival to the emperor, ascended the Ottoman throne.

The first act of Charles's administration was to appoint a diet of the empire, to be held at Worms, in order to concert with the princes proper measures for checking the progress of "those new and dangerous opinions which threatened to disturb the peace of Germany, and to overturn the religion of their ancestors." The opinions propagated by Luther and his followers were here meant. But all his efforts for that purpose were insufficient, as is related under the articles LUTHER and REFORMATION.

100 War between Francis and Charles. An. 1521

In 1521, the Spaniards, dissatisfied with the departure of their sovereign, whose election to the empire they foresaw would interfere with the administration of his own kingdom, and incensed at the avarice of the Flemings, to whom the direction of public affairs had been

been committed ſince the death of Cardinal Ximenes, ſeveral grandees, in order to ſhake off this oppreſſion, entered into an aſſociation, to which they gave the name of the *Sancta Juncta;* and the ſword was appealed to as the means of redreſs. This ſeemed to Francis a favourable juncture for reinſtating the family of John d'Albert in the kingdom of Navarre. Charles was at a diſtance from that part of his dominions, and the troops uſually ſtationed there had been called away to quell the commotions in Spain. A French army, under Andrew de Foix, ſpeedily conquered Navarre; but that young and inexperienced nobleman, puſhed on by military ardour, ventured to enter Caſtile. The Spaniards, though divided among themſelves, united againſt a foreign enemy, routed his forces, took him priſoner, and recovered Navarre in a ſhorter time than he had ſpent in ſubduing it.

Hoſtilities thus begun in one quarter, between the rival monarchs, ſoon ſpread to another. The king of France encouraged the duke of Bouillon to make war againſt the emperor, and to invade Luxembourg. Charles, after humbling the duke, attempted to enter France; but was repelled and worſted before Mezieres by the famous Chevalier Bayard, diſtinguiſhed among his cotemporaries by the appellation of *The Knight without fear and without reproach;* and who united the talents of a great general to the punctilious honour and romantic gallantry of the heroes of chivalry. Francis broke into the Low Countries, where, by an exceſs of caution, an error not natural to him, he loſt an opportunity of cutting off the whole imperial army; and, what was of ſtill more conſequence, he diſguſted the conſtable Bourbon, by giving the command of the van to the duke of Alençon.

During theſe operations in the field, an unſucceſsful congreſs was held at Calais, under the mediation of Henry VIII. It ſerved only to exaſperate the parties which it was intended to reconcile. A league was ſoon after concluded, by the intrigues of Wolſey, between the pope, Henry, and Charles, againſt France. Leo had already entered into a ſeparate league with the emperor, and the French were faſt loſing ground in Italy.

The inſolence and exactions of Mareſhal de Lautrec, governor of Milan, had totally alienated the affections of the Milaneſe from France. They reſolved to expel the troops of that nation, and put themſelves under the government of Francis Sforza, brother to Maximilian their late duke. In this reſolution, they were encouraged by the pope, who excommunicated Lautrec, and

101 Rapid conqueſts of Charles.

took into his pay a conſiderable body of Swiſs. The papal army, commanded by Proſper Colonna, an experienced general, was joined by ſupplies from Germany and Naples; while Lautrec, neglected by his court, and deſerted by the Swiſs in its pay, was unable to make head againſt the enemy. The city of Milan was betrayed by the inhabitants to the confederates; Parma and Placentia were united to the eccleſiaſtical ſtate; and of their conqueſts in Lombardy, only the town of Cremona, the caſtle of Milan, and a few inconſiderable forts, remained in the hands of the French.

Leo X. received the accounts of this rapid ſucceſs with ſuch tranſports of joy, as are ſaid to have brought on a fever, which occaſioned his death. The ſpirit of the confederacy was broken, and its operations ſuſpended by this accident. The Swiſs were recalled; ſome other mercenaries diſbanded for want of pay; and only the Spaniards, and a few Germans in the emperor's ſervice, remained to defend the duchy of Milan. But Lautrec, who with the remnant of his army had taken ſhelter in the Venetian territories, deſtitute both of men and money, was unable to improve this favourable opportunity as he wiſhed. All his efforts were rendered ineffectual by the vigilance and ability of Colonna and his aſſociates.

Meantime much diſcord prevailed in the conclave. Wolſey's name, notwithſtanding all the emperor's magnificent promiſes, was ſcarcely mentioned there. Julio de Medici, Leo's nephew, thought himſelf ſure of the election; when, by an unexpected turn of fortune, Cardinal Adrian of Utrecht, Charles's preceptor, who at that time governed Spain in the emperor's name, was unanimouſly raiſed to the papacy, to the aſtoniſhment of all Europe and the great diſguſt of the Italians.

Francis, rouſed by the riſing conſequence of his rival, reſolved to exert himſelf with freſh vigour, in order to wreſt from him his late conqueſts in Lombardy. 102 Francis invades Italy.

Lautrec received a ſupply of money, and a reinforcement of 10,000 Swiſs. With this reinforcement he was enabled once more to act offenſively, and even to advance within a few miles of the city of Milan; when money again failing him, and the Swiſs growing mutinous, he was obliged to attack the imperialiſts in their camp at Bicocca, where he was repulſed with great ſlaughter, having loſt his braveſt officers and beſt troops. Such of the Swiſs as ſurvived ſet out immediately for their own country; and Lautrec, deſpairing of being able to keep the field, retired into France. Genoa, which ſtill remained ſubject to Francis, and made it eaſy to execute any ſcheme for the recovery of Milan, was ſoon after taken by Colonna: the authority of the emperor and his faction was everywhere eſtabliſhed in Italy. The citadel of Cremona was the ſole fortreſs which remained in the hands of the French.

The affliction of Francis for ſuch a ſucceſſion of misfortunes was augmented by the unexpected arrival of an Engliſh herald, who in the name of his ſovereign declared war againſt France. The courage of this excellent prince, however, did not forſake him; though his treaſury was exhauſted by expenſive pleaſures, no leſs than by hoſtile enterpriſes, he aſſembled a conſiderable army, and put his kingdom in a poſture of defence for reſiſting this new enemy, without abandoning any of the ſchemes which he was forming againſt the emperor. He was ſurpriſed, but not alarmed, at ſuch a denunciation.

Meanwhile Charles, willing to draw as much advantage as poſſible from ſo powerful an ally, paid a ſecond viſit to the court of England in his way to Spain, where his preſence was become neceſſary. 103 Charles viſits England a ſecond time.

His ſucceſs exceeded his moſt ſanguine expectations. He not only gained the entire friendſhip of Henry, who publicly ratified the treaty of Bruges; but diſarmed the reſentment of Wolſey, by aſſuring him of the papacy on Adrian's death; an event ſeemingly not diſtant, by reaſon of his age and infirmities. In conſequence of theſe negociations an Engliſh army invaded France, under the command of the earl of Surrey; who, at the end of the campaign, was obliged to retire, with his forces greatly reduced,

Spain.

reduced, without being able to make himſelf maſter of one place within the French frontier. Charles was more fortunate in Spain: he ſoon quelled the tumults which had there ariſen in his abſence.

While the Chriſtian princes were thus waſting each other's ſtrength, Solyman the Magnificent entered Hungary, and made himſelf maſter of Belgrade, reckoned the chief barrier of that kingdom againſt the Turkiſh power. Encouraged by this ſucceſs, he turned his victorious arms againſt the iſland of Rhodes, at that time the ſeat of the knights of St John of Jeruſalem;

104
Rhodes taken by Solyman.

and though every prince in that age acknowledged Rhodes to be the great bulwark of Chriſtendom in the eaſt, ſo violent was their animoſity againſt each other, that they ſuffered Solyman without diſturbance to carry on his operations againſt that city and iſland. Liſle Adam, the grandmaſter, made a gallant defence; but, after incredible efforts of courage, patience, and military conduct, during a ſiege of ſix months, he was obliged to ſurrender the place, having obtained an honourable capitulation from the ſultan, who admired and reſpected his heroic qualities (ſee RHODES and MALTA). Charles and Francis were equally aſhamed of having occaſioned ſuch a loſs to Chriſtendom by their conteſts; and the emperor, by way of reparation, granted to the knights of St John the ſmall iſland of Malta, where they fixed their reſidence, and continued long to retain their ancient ſpirit, though much diminiſhed in power and ſplendour.

Adrian VI. though the creature of the emperor, and devoted to his intereſt, endeavoured to aſſume the impartiality which became the common father of Chriſtendom, and laboured to reconcile the contending princes, that they might unite in a league againſt Solyman, whoſe conqueſt of Rhodes rendered him more formidable than ever to Europe. The Italian ſtates were no leſs deſirous of peace than the pope: and ſo much regard was paid by the hoſtile powers to the exhortations of his holineſs, and to a bull which he iſſued, requiring all Chriſtian princes to conſent to a truce for three years, that the imperial, the French, and the Engliſh ambaſſadors at Rome, were empowered to treat of that matter; but while they waſted their time in fruitleſs negociations, their maſters were continuing their preparations for war; and other negociations ſoon took place.

105
A powerful confederacy againſt Francis.

The confederacy againſt France became more formidable than ever.

The Venetians, who had hitherto adhered to the French intereſt, formed engagements with the emperor for ſecuring Francis Sforza in the poſſeſſion of the duchy of Milan; and the pope, from a perſuaſion that the ambition of the French monarch was the only obſtacle to peace, acceded to the ſame alliance. The Florentines, the dukes of Ferrara and Mantua, and all the Italian powers, followed this example. Francis was left without a ſingle ally, to reſiſt the efforts of a multitude of enemies, whoſe armies every where threatened, and whoſe territories encompaſſed his dominions. The emperor in perſon menaced France with an invaſion on the ſide of Guienne; the forces of England and the Netherlands hovered over Picardy, and a numerous body of Germans was preparing to ravage Burgundy.

The dread of ſo many and ſuch powerful adverſaries, it was thought, would have obliged Francis to keep wholly on the defenſive, or at leaſt have prevented him from entertaining any thoughts of marching into Italy. But before his enemies were able to ſtrike a blow, Francis had aſſembled a great army, with which he hoped to diſconcert all the emperor's ſchemes, by marching it in perſon into Italy: and this bold meaſure, the more formidable becauſe unexpected, could ſcarcely have failed of the deſired effect, had it been immediately carried into execution. But the diſcovery of a domeſtic conſpiracy, which threatened the deſtruction of his kingdom, obliged Francis to ſtop ſhort at Lyons.

106
Francis marches towards Italy, but is obliged to return by a domeſtic conſpiracy.

Charles duke of Bourbon, lord high conſtable of France, was a prince of the moſt ſhining merit: his great talents equally fitted him for the council or the field, while his eminent ſervices to the crown intitled him to its firſt favour. But unhappily Louiſa ducheſs of Angouleme, the king's mother, had contracted a violent averſion againſt the houſe of Bourbon, and had taught her ſon, over whom ſhe had acquired an abſolute aſcendant, to view all the conſtable's actions with a jealous eye. After repeated affronts he retired from court, and began to liſten to the advances of the emperor's miniſters. Meantime the ducheſs of Bourbon died; and as the conſtable was no leſs amiable than accompliſhed, the ducheſs of Angouleme, ſtill ſuſceptible of the tender paſſions, formed the ſcheme of marrying him. But Bourbon, who might have expected every thing to which an ambitious mind can aſpire, from the doating fondneſs of a woman who governed her ſon and the kingdom, incapable of imitating Louiſa in her ſudden tranſition from hate to love, or of meanly counterfeiting a paſſion for one who had ſo long purſued him with unprovoked malice, rejected the match with diſdain, and turned the propoſal into ridicule. At once deſpiſed and inſulted by the man whom love only could have made her ceaſe to perſecute, Louiſa was filled with all the rage of diſappointed woman; ſhe reſolved to ruin, ſince ſhe could not marry, Bourbon. For this purpoſe ſhe commenced an iniquitous ſuit againſt him; and by the chicanery of Chancellor du Prat, the conſtable was ſtripped of his whole family-eſtate. Driven to deſpair by ſo many injuries, he entered into a ſecret correſpondence with the emperor and the king of England; and he propoſed, as ſoon as Francis ſhould have croſſed the Alps, to raiſe an inſurrection among his numerous vaſſals, and introduce foreign enemies into the heart of France.

Happily Francis got intimation of this conſpiracy before he left the kingdom; but not being ſufficiently convinced of the conſtable's guilt, he ſuffered ſo dangerous a foe to eſcape; and Bourbon entering into the emperor's ſervice, employed all the force of his enterpriſing genius, and his great talents for war, to the prejudice of his prince and his native country.

In conſequence of the diſcovery of this plot, and the eſcape of the powerful conſpirator, Francis relinquiſhed his intention of leading his army in perſon into Italy. He was ignorant how far the infection had ſpread among his ſubjects, and afraid that his abſence might encourage them to make ſome deſperate attempt in favour of a man ſo much beloved. He did not, however, abandon his deſign on the Milaneſe, but ſent forward an army of 30,000 men, under the command of Admiral Bonnivet.

107
French army enters Italy.

Colonna, who was entruſted with the defence of that duchy, was in no condition to reſiſt ſuch a force; and the city of Milan, on which the whole territory depends,

Spain. pends, muſt have fallen into the hands of the French, had not Bonnivet, who poſſeſſed none of the talents of a general, waſted his time in frivolous enterpriſes, till the inhabitants recovered from their conſternation. The imperial army was reinforced. Colonna died; and Lannoy, viceroy of Naples, ſucceeded him in the command: but the chief direction of military operations was committed to Bourbon and the marquis de Peſcara, the greateſt generals of their age. Bonnivet, deſtitute of troops to oppoſe this new army, and ſtill more of the talents which could render him a match for its leaders, after various movements and encounters, was reduced to the neceſſity of attempting a retreat into France.
108 He was followed by the imperial generals, and routed
Defeated at Biagraſſa. at Biagraſſa, where the famous Chevalier Bayard was killed.

The emperor and his allies were leſs ſucceſsful in their attempts upon France. They were baffled in every quarter: and Francis, though ſtripped of his Italian dominions, might ſtill have enjoyed in ſafety the glory of having defended his native kingdom againſt one half of Europe, and have bid defiance to all his enemies; but underſtanding that the king of England, diſcouraged by his former fruitleſs enterpriſes, and diſguſt-
109 Francis determines to enter Italy in perſon. ed with the emperor, was making no preparations for any attempt on Picardy, his ancient ardour ſeized him for the conqueſt of Milan, and he determined, notwithſtanding the advanced ſeaſon, to march into Italy.

The French army no ſooner appeared in Piedmont, than the whole Milaneſe was thrown into conſternation. The capital opened its gates. The forces of the emperor and Sforza retired to Lodi: and had Francis been ſo fortunate as to purſue them, they muſt have abandoned that poſt, and been totally diſperſed; but his evil genius led him to beſiege Pavia, a town of conſiderable ſtrength, well garriſoned, and defended by An-
110 tonio de Leyva, one of the braveſt officers in the Spa-
Is defeated and taken priſoner at Pavia. niſh ſervice; before which place he was defeated and taken priſoner on the twenty-fourth day of February 1524.

An. 1524. The captivity of Francis filled all Europe with alarm. Almoſt the whole French army was cut off; Milan was immediately abandoned; and in a few weeks not a Frenchman was left in Italy. The power of the emperor, and ſtill more his ambition, became an object of univerſal terror; and reſolutions were everywhere taken to ſet bounds to it. Meanwhile Francis, deeply impreſſed with a ſenſe of his misfortune, wrote to his mother Louiſa, whom he had left regent of the kingdom, the following ſhort but expreſſive letter: "All, Madam,
111 is loſt but honour." The ſame courier that carried this
Hypocritical conduct of Charles. letter, carried alſo diſpatches to Charles; who received the news of the ſignal and unexpected ſucceſs which had crowned his arms with the moſt hypocritical moderation. He would not ſuffer any public rejoicings to be made on account of it; and ſaid, he only valued it, as it would prove the occaſion of reſtoring peace to Chriſtendom. Louiſa, however, did not truſt to thoſe appearances; if ſhe could not preſerve what was yet left, ſhe determined at leaſt that nothing ſhould be loſt through her negligence or weakneſs. Inſtead of giving herſelf up to ſuch lamentations as were natural to a woman ſo remarkable for maternal tenderneſs, ſhe diſcovered all the foreſight, and exerted all the activity, of a conſummate politician. She took every poſſible meaſure for putting the kingdom in a poſture of defence, while ſhe employed all her addreſs to appeaſe the reſentment and to gain the friendſhip of England; and a ray of comfort from that quarter ſoon broke in upon the French affairs.

Though Henry VIII. had not entered into the war againſt France from any concerted political views, he had always retained ſome imperfect idea of that balance of power which it was neceſſary to maintain between Charles and Francis; and the preſervation of which he boaſted to be his peculiar office. By his alliance with the emperor, he hoped to recover ſome part of thoſe territories on the continent which had belonged to his anceſtors; and therefore willingly contributed to give him the aſcendency above his rival; but having never dreamt of any event ſo deciſive and fatal as the victory at Pavia, which ſeemed not only to have broken, but to have annihilated the power of Francis, he now became ſenſible of his own danger, as well as that of all Europe, from the loſs of a proper counterpoiſe to the power of 112
Charles. Inſtead of taking advantage of the diſtreſſed France aſſiſted by Henry VIII.
condition of France, Henry therefore determined to aſſiſt her in her preſent calamities. Some diſguſts alſo had taken place between him and Charles, and ſtill more between Charles and Wolſey. The elevation of the cardinal of Medici to St Peter's chair, on the death of Adrian, under the name of Clement VII. had made the Engliſh miniſter ſenſible of the inſincerity of the emperor's promiſes, while it extinguiſhed all his hopes of the papacy; and he reſolved on revenge. Charles, too, had ſo ill ſupported the appearance of moderation which he aſſumed, when firſt informed of his good fortune, that he had already changed his uſual ſtyle to Henry; and inſtead of writing to him with his own hand, and ſubſcribing himſelf "your affectionate ſon and couſin," he dictated his letters to a ſecretary, and ſimply ſubſcribed himſelf "Charles." Influenced by all theſe motives, together with the glory of raiſing a fallen enemy, Henry liſtened to the flattering ſubmiſſions of Louiſa; entered into a defenſive alliance with her as regent of France, and engaged to uſe his beſt offices in order to procure the deliverance of her ſon from a ſtate of captivity. 113

Meanwhile Francis was rigorouſly confined; and ſe- Francis ſeverely uſed by his conqueror.
vere conditions being propoſed to him as the price of his liberty, he drew his dagger, and, pointing it at his breaſt, cried, "'Twere better that a king ſhould die thus!" His hand was withheld: and flattering himſelf, when he grew cool, that ſuch propoſitions could not come directly from Charles, he deſired that he might be removed to Spain, where the emperor then reſided. His requeſt was complied with; but he languiſhed long before he obtained a ſight of his conqueror. At laſt he was favoured with a viſit; and the emperor dreading a general combination againſt him, or that Francis, as he threatened, might, in the obſtinacy of his heart, reſign his crown to the dauphin, agreed to abate ſomewhat of his former demands. A treaty was accordingly concluded at Madrid; in conſequence of which Francis obtained his liberty. The chief article in this treaty was, that Burgundy ſhould be reſtored to Charles as the rightful inheritance of his anceſtors, and 114
that Francis's two eldeſt ſons ſhould be immediately de- Is at laſt releaſed.
livered up as hoſtages for the performance of the conditions ſtipulated. The exchange of the captive monarch

Spain. narch for his children was made on the borders between France and Spain. The moment that Francis entered his own dominions, he mounted a Turkish horse, and putting it to its speed, waved his hand, and cried aloud several times, "I am yet a king! I am yet a king."

115 Refuses to execute the conditions of his release.

Francis never meant to execute the treaty of Madrid: he had even left a protest in the hands of notaries before he signed it, that his consent should be considered as an involuntary deed, and be deemed null and void. Accordingly, as soon as he arrived in France, he assembled the states of Burgundy, who protested against the article relative to their province; and Francis coldly replied to the imperial ambassadors, who urged the immediate execution of the treaty, that he would religiously perform the articles relative to himself, but in those affecting the French monarchy, he must be directed by the sense of the nation. He made the highest acknowledgements to the king of England for his friendly interposition, and offered to be entirely guided by his counsels. Charles and his ministers saw that they were over-reached in those very arts of negotiation in which they so much excelled, while the Italian states observed with pleasure, that Francis was resolved not to execute a treaty which they considered as dangerous to the liberties of Europe. Clement absolved him from the oath which he had taken at Madrid; and the kings of France and England, the pope, the Swiss, the Venetians, the Florentines, and the duke of Milan, entered into an alliance, to which they gave the name of the *Holy League*, because his Holiness was at the head of it, in order to oblige the emperor to deliver up Francis's two sons on the payment of a reasonable ransom, and to re-establish Sforza in the quiet possession of the Milanese.

In consequence of this league, the confederate army took the field, and Italy once more became the scene of war. But Francis, who it was thought would have infused spirit and vigour into the whole body, had gone through such a scene of distress, that he was become diffident of himself, distrustful of his fortune, and desirous of tranquillity. He flattered himself, that the dread alone of such a confederacy would induce Charles to listen to what was equitable, and therefore neglected to send due reinforcements to his allies in Italy. Meantime the duke of Bourbon, who commanded the Imperialists, had made himself master of the whole Milanese, of which the emperor had promised him the investiture; and his troops beginning to mutiny for want of pay, he led them to Rome, and promised to enrich them with the spoils of that city. He was as good as his word; for though he himself was slain in planting a scaling ladder against the walls, his soldiers, rather enraged than discouraged by his death, mounted to the assault with the utmost ardour, animated by the greatness of the prize, and, entering the city sword in hand, plundered it for several days.

116 Rome taken by the imperialists,

117 and most cruelly plundered.

Never did Rome in any age suffer so many calamities, not even from the Barbarians, by whom she was often subdued, the Huns, Vandals, or Goths, as now from the subjects of a Christian and Catholic monarch. Whatever was respectable in modesty, or sacred in religion, seemed only the more to provoke the rage of the soldiery. Virgins suffered violation in the arms of their parents, and upon those altars to which they had fled for safety. Venerable prelates, after enduring every indignity and every torture, were thrown into dungeons, and menaced with the most cruel death, in order to make them reveal their secret treasures. Clement himself, who had neglected to make his escape in time, was taken prisoner, and found that the sacredness of his character could neither procure him liberty nor respect. He was confined till he should pay an enormous ransom imposed by the victorious army, and surrender to the emperor all the places of strength belonging to the church.

118 The pope confined.

119 Shameful hypocrisy of Charles.

Charles received the news of this extraordinary event with equal surprise and pleasure; but in order to conceal his joy from his Spanish subjects, who were filled with horror at the insult offered to the sovereign pontiff, and to lessen the indignation of the rest of Europe, he expressed the most profound sorrow for the success of his arms. He put himself and his court into mourning; stopped the rejoicings for the birth of his son Philip, and ordered prayers to be put up in all the churches of Spain for the recovery of the pope's liberty, which he could immediately have procured by a letter to his generals.

The concern expressed by Henry and Francis for the calamity of their ally was more sincere. Alarmed at the progress of the imperial arms, they had, even before the taking of Rome, enter into a closer alliance, and agreed to invade the Low Countries with a powerful army; but no sooner did they hear of the pope's captivity, than they changed, by a new treaty, the scene of the projected war from the Netherlands to Italy, and resolved to take the most vigorous measures for restoring him to liberty. Henry, however, contributed only money. A French army entered Italy, under the command of Marshal Lautrec; Clement obtained his freedom; and war was for a time carried on by the confederates with success; but the death of Lautrec, and the revolt of Andrew Doria, a Genoese admiral in the service of France, entirely changed the face of affairs. The French army was utterly ruined; and Francis, discouraged and almost exhausted by so many unsuccessful enterprises, began to think of peace, and of obtaining the release of his sons by concessions, not by the terror of his arms.

120 A French army enters Italy, but is utterly ruined.

At the same time Charles, notwithstanding the advantages he had gained, had many reasons to wish for an accommodation. Sultan Solyman having overrun Hungary, was ready to break in upon the Austrian territories with the whole force of the East; and the progress of the Reformation in Germany threatened the tranquillity of the empire. In consequence of this situation of affairs, though pride made both parties conceal or dissemble their real sentiments, two ladies were permitted to restore peace to Europe. Margaret of Austria, Charles's aunt, and Louisa, Francis's mother, met in 1529 at Cambray, and settled the terms of accommodation between the French king and the emperor. Francis agreed to pay two millions of crowns as the ransom of his two sons, to resign the sovereignty of Flanders and Artois, and to forego all his Italian claims; and Charles ceased to demand the restitution of Burgundy.

121 Peace concluded at Cambray.

All the steps of this negociation had been communicated to the king of England; and Henry was, on that occasion, so generous to his friend and ally Francis, that he sent him an acquittal of near six hundred thousand crowns, in order to enable him to fulfil his agreement

with

Spain.

with Charles. But Francis's Italian confederates were less satisfied with the treaty of Cambray. They were almost wholly abandoned to the will of the emperor; and seemed to have no other means of security left but his equity and moderation. Of these, from his past conduct, they had not formed the most advantageous idea. But Charles's present circumstances, more especially in regard to the Turks, obliged him to behave with a generosity inconsistent with his character. The Florentines alone, whom he reduced under the dominion of the family of Medici, had reason to complain of his severity. Sforza obtained the investiture of Milan and his pardon: and every other power experienced the lenity of the conqueror.

122
Charles goes into Germany.

After having received the imperial crown from the hands of the pope at Bologna, Charles proceeded on his journey to Germany, where his presence was become highly necessary; for although the conduct and valour of his brother Ferdinand, on whom he had conferred the hereditary dominions of the house of Austria, and who had been elected king of Hungary, had obliged Solyman to retire with infamy and loss, his return was to be feared, and the disorders of religion were daily increasing; an account of which, and of the emperor's transactions with the Protestants, is given under the article REFORMATION.

123
He undertakes an expedition against the state of Barbary.
An. 1541.

Charles having exerted himself as much as he could against the reformers, undertook his first expedition against the piratical states of Africa. Barbary, or that part of the African continent lying along the coast of the Mediterranean sea, was then nearly in the same condition which it is at present. Morocco, Algiers, and Tunis, were its principal states; and the two last were nests of pirates. Barbarossa, a famous corsair, had succeeded his brother in the kingdom of Algiers, which he had formerly assisted him to usurp. He regulated with much prudence the interior police of his kingdom, carried on his piracies with great vigour, and extended his conquests on the continent of Africa; but perceiving that the natives submitted to his government with impatience, and fearing that his continual depredations would one day draw upon him a general combination of the Christian powers, he put his dominions under the protection of the grand seignior. Solyman, flattered by such an act of submission, and charmed with the boldness of the man, offered him the command of the Turkish fleet. Proud of this distinction, Barbarossa repaired to Constantinople, and made use of his influence with the sultan to extend his own dominion. Partly by force, partly by treachery, he usurped the kingdom of Tunis; and being now possessed of greater power, he carried on his depredations against the Christian states with more destructive violence than ever.

Daily complaints of the piracies and ravages committed by the galleys of Barbarossa were brought to the emperor by his subjects, both in Spain and Italy; and all Christendom seemed to look up to him, as its greatest and most fortunate prince, for relief from this new and odious species of oppression. At the same time Muley-Hascen, the exiled king of Tunis, finding none of the African princes able or willing to support him in recovering his throne, applied to Charles for assistance against the usurper. Equally desirous of delivering his dominions from the dangerous neighbourhood of Barbarossa, of appearing as the protector of an unfortunate prince, and of acquiring the glory annexed in that age to every expedition against the Mahometans, the emperor readily concluded a treaty with Muley Hascen, and set sail for Tunis with a formidable armament. The Goletta, a sea-port town, fortified with 300 pieces of cannon, was taken, together with all Barbarossa's fleet: he was defeated in a pitched battle, and 10,000 Christian slaves, having knocked off their fetters, and made themselves masters of the citadel, Tunis was preparing to surrender. But while Charles was deliberating on the conditions, his troops fearing that they would be deprived of the booty which they had expected, broke suddenly into the town, and pillaged and massacred without distinction. Thirty thousand persons perished by the sword, and 10,000 were made prisoners. The sceptre was restored to Muley Hascen, on condition that he should acknowledge himself a vassal of the crown of Spain, put into the emperor's hands all the fortified sea-ports in the kingdom of Tunis, and pay annually 12,000 crowns for the subsistence of the Spanish garrison in the Goletta. These points being settled, and 20,000 Christian slaves freed from bondage either by arms or by treaty, Charles returned to Europe, where his presence was become necessary; while Barbarossa, who had retired to Bona, recovered new strength, and again became the tyrant of the ocean.

124
Tunis taken, and the inhabitants cruelly massacred.

125
Francis attempts in vain to revive his pretensions to Italy.

The king of France took advantage of the emperor's absence to revive his pretensions in Italy. The treaty of Cambray had repressed but not extinguished the flames of discord. Francis in particular, who waited only for a favourable opportunity of recovering the territories and reputation which he had lost, continued to negotiate against his rival with different courts. But all his negotiations were disconcerted by unforeseen accidents. The death of Clement VII. (whom he had gained by marrying his son the duke of Orleans, afterwards Henry II. to Catharine of Medici, the niece of that pontiff), deprived him of all the support which he hoped to receive from the court of Rome. The king of England, occupied with domestic cares and projects, declined engaging in the affairs of the continent; and the Protestant princes, associated by the league of Smalkalde, to whom Francis had also applied, and who seemed disposed at first to listen to him, filled with indignation and resentment at the cruelty with which some of their reformed brethren had been treated in France, refused to have any connection with the enemy of their religion.

Francis was neither cruel nor bigotted: he was too indolent to concern himself about religious disputes; but his principles becoming suspected, at a time when the emperor was gaining immortal glory by his expedition against the infidels, he found it necessary to vindicate himself by some extraordinary demonstration of reverence for the established faith. The indiscreet zeal of some Protestant converts furnished him with the occasion. They had affixed to the gates of the Louvre and other public places papers containing indecent reflections on the rites of the Romish church. Six of the persons concerned in this rash action were seized; and the king, pretending to be struck with horror at their blasphemies, appointed a solemn procession, in order to avert the wrath of heaven. The holy sacrament was carried through the city of Paris in great pomp: Francis walked uncovered before it, bearing a torch in his hand;

126
His barbarity to the Protestants.

Spain. hand; the princes of the blood supported the canopy over it; the nobles walked behind. In presence of this numerous assembly, the king declared, that if one of his hands were infected with heresy, he would cut it off with the other; "and I would sacrifice (added he) even my own children, if found guilty of that crime." As an awful proof of his sincerity, the six unhappy persons who had been seized were publicly burnt, before the procession was finished, and in the most cruel manner. They were fixed upon a machine which descended into the flames, and retired alternately, until they expired.—No wonder that the Protestant princes were incensed at such barbarity!

127 Causes an army march towards Italy.

Francis, though unsupported by any ally, commanded his army to advance towards the frontiers of Italy, under pretence of chastising the duke of Milan for a breach of the law of nations, in putting to death his ambassador. The operations of war, however, soon took a new direction. Instead of marching directly to the Milanese, Francis commenced hostilities against the duke of Savoy, with whom he had cause to be dissatisfied, and on whom he had some claims; and before the end of the campaign, this feeble prince saw himself stripped of all his dominions, except the province of

128 Geneva throws off the yoke of the duke of Savoy.

Piedmont. To complete his misfortunes, the city of Geneva, the sovereignty of which he claimed, and where the reformed opinions had already got footing, threw off his yoke; and its revolt drew along with it the loss of the adjacent territory. Geneva was then an imperial city, and till lately remained entirely free *.

* See *Geneva*.

In this extremity the duke of Savoy saw no resource but in the emperor's protection; and as his misfortunes were chiefly occasioned by his attachment to the imperial interest, he had a title to immediate assistance. But Charles, who was just returned from his African expedition, was not able to lend him the necessary support. His treasury was entirely drained, and he was obliged to disband his army till he could raise new supplies. Mean time the death of Sforza duke of Milan entirely changed the nature of the war, and afforded the emperor full leisure to prepare for action. The French monarch's pretext for taking up arms was at once cut off; but as the duke died without issue, all Francis's rights to the duchy of Milan, which he had yielded only to Sforza and his descendants, returned to him in full force. He instantly renewed his claim to it; and if he had ordered his army immediately to advance, he might have

129 Charles takes possession of Milan.

made himself master of it. But he unfortunately wasted his time in fruitless negotiations, while his more politic rival took possession of the duchy as a vacant fief of the empire; and though Charles seemed still to admit the equity of Francis's claim, he delayed granting the investiture under various pretences, and was secretly taking every possible measure to prevent him from regaining footing in Italy.

During the time gained in this manner, Charles had recruited his finances, and of course his armies; and finding himself in a condition for war, he at last threw off the mask under which he had so long concealed his designs from the court of France. Entering Rome with great pomp, he pronounced before the pope and cardinals, assembled in full consistory, a violent invective against Francis, by way of reply to his propositions concerning the investiture of Milan. Yet Francis, by an

130 Weakness of Francis.

unaccountable fatality, continued to negotiate, as if it had been still possible to terminate their differences in an amicable manner; and Charles, finding him so eager to run into the snare, favoured the deception, and, by seeming to listen to his proposals, gained yet more time for the execution of his ambitious projects.

131 Charles attempts to subvert the French monarchy,

If misfortunes had rendered Francis too diffident, success had made Charles too sanguine. He presumed on nothing less than the subversion of the French monarchy; nay, he considered it as a certain event. Having chased the forces of his rival out of Piedmont and Savoy, he pushed forward at the head of 50,000 men, contrary to the advice of his most experienced ministers and generals, to invade the southern provinces of France; while two other armies were ordered to enter it, the one on the side of Picardy, the other on the side of Champagne. He thought it impossible that Francis could resist so many unexpected attacks on such different quarters; but he found himself mistaken.

132 But is disappointed in his designs.

The French monarch fixed on the most effectual plan for defeating the invasion of a powerful enemy; and he prudently persevered in following it, though contrary to his own natural temper and to the genius of his people. He determined to remain altogether upon the defensive, and to deprive the enemy of subsistence by laying waste the country before them. The execution of this plan was committed to the mareschal Montmorency its author, a man happily fitted for such a trust by the inflexible severity of his disposition. He made choice of a strong camp, under the walls of Avignon, at the confluence of the Rhone and Durance, where he assembled a considerable army; while the king, with another body of troops, encamped at Valence, higher up the Rhone. Marseilles and Arles were the only towns he thought it necessary to defend; and each of these he furnished with a numerous garrison of his best troops. The inhabitants of the other towns were compelled to abandon their habitations: the fortifications of such places as might have afforded shelter to the enemy were thrown down; corn, forage, and provisions of every kind, were carried off or destroyed; the mills and ovens were ruined, and the wells filled up or rendered useless.

This devastation extended from the Alps to Marseilles, and from the sea to the confines of Dauphiny; so that the emperor, when he arrived with the van of his army on the confines of Provence, instead of that rich and populous country which he expected to enter, beheld nothing but one vast and desert solitude. He did not, however, despair of success, though he saw that he would have many difficulties to encounter; and as an encouragement to his officers, he made them liberal promises of lands and honours in France. But all the land which any of them obtained was a grave, and their master lost much honour by this rash and presumptuous enterprise. After unsuccessfully investing Marseilles and Arles, after attempting in vain to draw Montmorency from his camp at Avignon, and not daring to attack it, Charles having spent two inglorious months in Provence, and lost one half of his troops by disease or by famine, was under the necessity of ordering a retreat; and though he was some time in motion before the enemy suspected his intention, it was conducted with so much precipitation and disorder, as to deserve the name of a flight, since the light troops of France turned it into a perfect rout. The invasion of Picardy

Spain.

Picardy was not more ſucceſsful: the imperial forces were obliged to retire without effecting any conqueſt of importance.

Charles had no ſooner conducted the ſhattered remains of his army to the frontiers of Milan, than he ſet out for Genoa; and unwilling to expoſe himſelf to the ſcorn of the Italians after ſuch a reverſe of fortune, he embarked directly for Spain.

133 Violent animoſity between him and Francis.

Meanwhile Francis gave himſelf up to that vain reſentment which had formerly diſgraced the proſperity of his rival. They had frequently, in the courſe of their quarrels, given each other the lie, and mutual challenges had been ſent; which, though productive of no ſerious conſequences between the parties, had a powerful tendency to encourage the pernicious practice of duelling. Charles, in his invective pronounced at Rome, had publicly accuſed Francis of perfidy and breach of faith; Francis now exceeded Charles in the indecency of his accuſations. The dauphin dying ſuddenly, his death was imputed to poiſon: Montecuculi his cup-bearer was put to the rack; and that unhappy nobleman, in the agonies of torture, accuſed the emperor's generals Gonzaga and de Leyva, of inſtigating him to the deteſtable act. The emperor himſelf was ſuſpected; nay, this extorted confeſſion, and ſome obſcure hints, were conſidered as inconteſtable proofs of his guilt; though it was evident to all mankind, that neither Charles nor his generals could have any inducement to perpetrate ſuch a crime, as Francis was ſtill in the vigour of life himſelf, and had two ſons beſides the dauphin, grown up to a good age.

But the incenſed monarch's reſentment did not ſtop here. Francis was not ſatisfied with endeavouring to blacken the character of his rival by an ambiguous teſtimony which led to the moſt injurious ſuſpicions, and upon which the moſt cruel conſtructions had been put; he was willing to add rebellion to murder. For this purpoſe he went to the parliament of Paris; where being ſeated with the uſual ſolemnities, the advocate-general appeared, and accuſed Charles of Auſtria (ſo he affected to call the emperor) of having violated the treaty of Cambray, by which he was freed from the homage due to the crown of France for the counties of Artois and Flanders; adding, that this treaty being now void, he was ſtill to be conſidered as a vaſſal of France, and conſequently had been guilty of rebellion

134 Charles ſummoned to appear at Paris.

in taking arms againſt his ſovereign. The charge was ſuſtained, and Charles was ſummoned to appear before the parliament of Paris at a day fixed. The term expired; and no perſon appearing in the emperor's name, the parliament gave judgement, that Charles of Auſtria had forfeited, by rebellion and contumacy, the counties of Flanders and Artois, and declared theſe fiefs reunited to the crown of France.

Francis, ſoon after this vain diſplay of his animoſity, marched into the Low Countries, as if he had intended to execute the ſentence pronounced by his parliament; but a ſuſpenſion of arms took place, through the interpoſition of the queens of France and Hungary, before any thing of conſequence was effected: and this ceſſation of hoſtilities was followed by a truce, concluded at Nice, through the mediation of the reigning pontiff Paul III. of the family of Farneſe, a man of a venerable character and pacific diſpoſition.

Each of theſe rival princes had ſtrong reaſons to incline them to peace. The finances of both were exhauſted; and the emperor, the more powerful of the two, was deeply impreſſed with the dread of the Turkiſh arms, which Francis had drawn upon him by a league with Solyman. In conſequence of this league, Barbaroſſa with a great fleet appeared on the coaſt of Naples; filled that kingdom with conſternation; landed without reſiſtance near Taranto; obliged Caſtro, a place of ſome ſtrength, to ſurrender; plundered the adjacent country; and was taking meaſures for ſecuring and extending his conqueſts, when the unexpected arrival of Doria, the famous Genoeſe admiral, together with the pope's galleys and a ſquadron of the Venetian fleet, made it prudent for him to retire. The ſultan's forces alſo invaded Hungary, where Mahmet the Turkiſh general, after gaining ſeveral inferior advantages, defeated the Germans in a great battle at Eſſek on the Drave. Happily for Charles and Europe it was not in Francis's power at this juncture either to join the Turks or aſſemble an army ſtrong enough to penetrate into the Milaneſe. The emperor, however, was ſenſible that he could not long reſiſt the efforts of two ſuch powerful confederates, nor expect that the ſame fortunate circumſtances would concur a ſecond time in his favour; he therefore thought it neceſſary, both for his ſafety and reputation, to give his conſent to a truce: and Francis choſe rather to run the riſk of diſobliging his new ally the ſultan, than to draw on his head the indignation, and perhaps the arms, of all Chriſtendom, by obſtinately obſtructing the re-eſtabliſhment of tranquillity, and contributing to the aggrandizement of the Infidels.

135 Francis leagues with the Turks.

136 A truce concluded.

Theſe conſiderations inclined the contending monarchs to liſten to the arguments of the holy father; but he found it impoſſible to bring about a final accommodation between them, each inflexibly perſiſting in aſſerting his own claims. Nor could he prevail on them to ſee one another, though both came to the place of rendezvous: ſo great was the remains of diſtruſt and rancour, or ſuch the difficulty of adjuſting the ceremonial! Yet, improbable as it may ſeem, a few days after ſigning the truce, the emperor, in his paſſage to Barcelona, being driven on the coaſt of Provence, Francis invited him to come aſhore; frankly viſited him on board his galley, and was received and entertained with the warmeſt demonſtrations of eſteem and affection. Charles, with an equal degree of confidence, paid the king next day a viſit at Aigues-mortes; where theſe two hoſtile rivals and vindictive enemies, who had accuſed each other of every kind of baſeneſs, converſing together with all the cordiality of brothers, ſeemed to vie with each other in expreſſions of reſpect and friendſhip.

137 Interview between Francis and Charles.

138 Advantage gained by the pope from this pacification.

Beſides the glory of having reſtored tranquillity to Europe, the pope gained a point of much conſequence to his family. He obtained for his grandſon, Margaret of Auſtria, the emperor's natural daughter, formerly wife of Alexander de Medici, whom Charles had raiſed to the ſupreme power in Florence. Laurenein de Medici, the kinſman and intimate companion of Alexander, had aſſaſſinated him by one of the blackeſt treaſons recorded in hiſtory. Under pretence of having ſecured him an aſſignation with a lady of the higheſt rank and great beauty, he drew him into a ſecret apartment of his houſe, and there ſtabbed him as he lay careleſsly on a couch, expecting the embrace of the lovely fair, whom he had often

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often solicited in vain. Laurenein, however, did not reap the fruits of his crime; for though some of his countrymen extolled him as a third Brutus, and endeavoured to seize this occasion for recovering their liberties, the government of Florence passed into the hands of Cosmo II. another kinsman of Alexander. Cosmo was desirous of marrying the widow of his predecessor; but the emperor chose rather to oblige the pope, by bestowing his daughter upon Octavio Farnese, son of the duke of Parma.

139
Charles distressed.

Charles had soon farther cause to be sensible of his obligations to the holy father for bringing about the treaty of Nice. His troops everywhere mutinied for want of pay, and the ability of his generals only could have prevented a total revolt. He had depended, as his chief resource for discharging the arrears due to his soldiers, upon the subsidies which he expected from his Castilian subjects. For this purpose he assembled the Cortes of Castile at Toledo; and having represented to them the great expence of his military operations, he proposed to levy such supplies as the present exigency of affairs demanded, by a general excise on commodities; but the Spaniards, who already felt themselves oppressed by a load of taxes unknown to their ancestors, and who had often complained that their country was drained of its wealth and inhabitants, in order to prosecute quarrels in which they had no interest, determined not to add voluntarily to their own burdens. The nobles, in particular, inveighed with great vehemence against the imposition proposed, as an encroachment on the valuable and distinguishing privilege of their order, that of being exempted from the payment of any tax. After employing arguments and promises in vain, Charles dismissed the assembly with indignation; and from that period neither the nobles nor the prelates have been called to the Cortes, on pretence that such as pay no part of the public taxes should not claim a vote in laying them on. These assemblies have since consisted merely of the procurators or representatives of 18 cities, two from each; in all 36 members, who are absolutely at the devotion of the crown.

140
The Spaniards refuse to assist him with money.

141
Inhabitants of Ghent rebel.

The citizens of Ghent, still more bold, broke out not long after into open rebellion against the emperor's government, on account of a tax which they judged contrary to their ancient privileges, and a decision of the council of Mechlin in favour of the imperial authority. Enraged at an unjust imposition, and rendered desperate on seeing their rights betrayed by that very court which was bound to protect them, they flew to arms, seized several of the emperor's officers, and drove such of the nobility as resided among them out of the city. Sensible, however, of their inability to support what their zeal had prompted them to undertake, and desirous of securing a protector against the formidable forces with which they might expect soon to be attacked, they offered to acknowledge the king of France as their sovereign, to put him into immediate possession of their city, and to assist him in recovering those provinces in the Netherlands which had anciently belonged to his crown. True policy directed Francis to comply with this proposal. The counties of Flanders and Artois were more valuable than the duchy of Milan, for which he had so long contended; and their situation in regard to France made it more easy to conquer or to defend them. But Francis over-rated the Milanese. He had lived in friendship with the emperor ever since their interview at Aigues-mortes, and Charles had promised him the investiture of that duchy. Forgetting, therefore, all his past injuries, and the deceitful promises by which he had been so often duped, the credulous, generous Francis, not only rejected the propositions of the citizens of Ghent, but communicated to the emperor his whole negociation with the malecontents.

142
Extreme credulity of Francis.

Judging of Charles's heart by his own, Francis hoped by this seemingly disinterested proceeding to obtain at once the investiture of Milan; and the emperor, well acquainted with the weakness of his rival, flattered him in this apprehension, for his own selfish purposes. His presence being necessary in the Netherlands, he demanded a passage through France. It was immediately granted him; and Charles, to whom every moment was precious, set out, notwithstanding the remonstrances of his council and the fears of his Spanish subjects, with a small but splendid train of 100 persons. He was met on the frontiers of France by the dauphin and the duke of Orleans, who offered to go into Spain, and remain there as hostages, till he should reach his own dominions; but Charles replied, that the king's honour was sufficient for his safety, and prosecuted his journey without any other security. The king entertained him with the utmost magnificence at Paris, and the two young princes did not take leave of him till he entered the Low Countries; yet he still found means to evade his promise, and Francis continued to believe him sincere.

143
He allows Charles to pass through his dominions.

144
Severity of Charles to the city of Ghent.

The citizens of Ghent, alarmed at the approach of the emperor, who was joined by three armies, sent ambassadors to implore his mercy, and offered to throw open their gates. Charles only condescended to reply, "That he would appear among them as a sovereign and a judge, with the sceptre and the sword." He accordingly entered the place of his nativity on the anniversary of his birth; and instead of that lenity which might have been expected, exhibited an awful example of his severity. Twenty-six of the principal citizens were put to death: a greater number was banished: the city was declared to have forfeited its privileges; a new system of laws and political administration was prescribed; and a large fine was imposed on the inhabitants, in order to defray the expence of erecting a citadel, together with an annual tax for the support of a garrison. They were not only despoiled of their ancient immunities, but made to pay, like conquered people, for the means of perpetuating their own slavery.

145
His base treatment of Francis.

Having thus re-established his authority in the Low Countries, and being now under no necessity of continuing that scene of falsehood and dissimulation with which he had amused the French monarch, Charles began gradually to throw aside the veil under which he had concealed his intentions with respect to the Milanese, and at last peremptorily refused to give up a territory of such value, or voluntarily to make such a liberal addition to the strength of an enemy by diminishing his own power. He even denied that he had ever made any promise which could bind him to an action so foolish, and so contrary to his own interest.

This transaction exposed the king of France to as much scorn as it did the emperor to censure. The credulous simplicity of Francis seemed to merit no other return, after experiencing so often the duplicity and artifices of his rival. He remonstrated, however, and exclaimed as if this had been the firſt circumſtance in which the emperor had deceived him. The inſult offered to his underſtanding affected him even more ſenſibly than the injury done to his intereſt; and he diſcovered ſuch reſentment as made it obvious that he would ſeize on the firſt opportunity of revenge, and that a new war would ſoon deſolate the European continent.

146
He is obliged to make conceſſions to the Proteſtants.

Meanwhile Charles was obliged to turn his attention towards the affairs of Germany. The Proteſtants having in vain demanded a general council, preſſed him earneſtly to appoint a conference between a ſelect number of divines of each party, in order to examine the points in diſpute. For this purpoſe a diet was aſſembled at Ratiſbon: and ſuch a conference, notwithſtanding the oppoſition of the pope, was held with great ſolemnity in the preſence of the emperor. But the divines choſen to manage the controverſy, though men of learning and moderation, were only able to ſettle a few ſpeculative opinions, all points relative to worſhip and juriſdiction ſerving to inflame the minds of the diſputants. Charles, therefore, finding his endeavours to bring about an accommodation ineffectual, and being impatient to cloſe the diet, prevailed on a majority of the members to approve of the following edict of receſs; viz. that the articles concerning which the divines had agreed, ſhould be held as points decided; that thoſe about which they had differed, ſhould be referred to the determination of a general council, or if that could not be obtained, to a national ſynod: and ſhould it prove impracticable alſo to aſſemble a ſynod of Germany, that a general diet of the empire ſhould be called within 18 months, in order to give final judgement on the whole controverſy; that, in the mean time, no innovations ſhould be attempted, nor any endeavours employed to gain proſelytes.

This diet gave great offence to the pope. The bare mention of allowing a diet, compoſed chiefly of laymen, to paſs judgement in regard to articles of faith, appeared to him no leſs criminal and profane than the worſt of thoſe hereſies which the emperor ſeemed ſo zealous to ſuppreſs. The Proteſtants alſo were diſſatisfied with it, as it conſiderably abridged the liberty which they at that time enjoyed. They murmured loudly againſt it; and Charles, unwilling to leave any ſeeds of diſcontent in the empire, granted them a private declaration, exempting them from whatever they thought injurious or oppreſſive in the receſs, and aſcertaining to them the full poſſeſſion of all their former privileges.

The ſituation of the emperor's affairs at this juncture made theſe extraordinary conceſſions neceſſary. He foreſaw a rupture with France to be unavoidable, and he was alarmed at the rapid progreſs of the Turks in Hungary. A great revolution had happened in that kingdom. John Zapol Scæpus, by the aſſiſtance of Solyman, had wreſted from the king of the Romans a conſiderable part of the country. John died, and left an infant ſon. Ferdinand attempted to take advantage of the minority, in order to repoſſeſs himſelf of the whole kingdom; but his ambition was diſappointed by the activity and addreſs of George Martinuzzi, biſhop of Waradin, who ſhared the regency with the queen. Senſible that he was unable to oppoſe the king of the Romans in the field, Martinuzzi ſatisfied himſelf with holding out the fortified towns, all of which he provided with every thing neceſſary for defence; and at the ſame time he ſent ambaſſadors to Solyman, beſeeching him to extend towards the ſon that imperial protection which had ſo generouſly maintained the father on his throne. Ferdinand uſed his utmoſt endeavours to thwart this negotiation, and even meanly offered to hold the Hungarian crown on the ſame ignominious condition by which John had held it, that of paying tribute to the Porte. But the ſultan ſaw ſuch advantages from eſpouſing the intereſt of the young king, that he inſtantly marched into Hungary; and the Germans, having formed the ſiege of Buda, were defeated with great ſlaughter before that city. Solyman, however, inſtead of becoming the protector of the infant ſovereign whom he had relieved, made uſe of this ſucceſs to extend his own dominions: he ſent the queen and her ſon into Tranſilvania, which province he allotted them, and added Hungary to the Ottoman empire.

Happily for the Proteſtants, Charles received intelligence of this revolution ſoon after the diet at Ratiſbon; and by the conceſſions which he made them, he obtained ſuch liberal ſupplies, both of men and money, as left him under little anxiety about the ſecurity of Germany.

147
Undertakes an unſucceſsful expedition againſt Algiers.

He therefore haſtened to join his fleet and army in Italy, in order to carry into execution a great and favourite enterpriſe which he had concerted againſt Algiers: though it would certainly have been more conſiſtent with his dignity to have conducted the whole force of the empire againſt Solyman, the common enemy of Chriſtendom, who was ready to enter his Auſtrian dominions. But many reaſons induced Charles to prefer the African expedition: he wanted ſtrength, or at leaſt money, to combat the Turks in ſo diſtant a country as Hungary; and the glory which he had formerly acquired in Barbary led him to hope for the like ſucceſs, while the cries of his Spaniſh ſubjects rouſed him to take vengeance on their ravagers. But the unfortunate event of this expedition has already been related under the article ALGIERS, N° 14—20.

148
War between Francis and Charles.

The loſs which the emperor ſuffered in this calamitous expedition encouraged the king of France to begin hoſtilities, on which he had been for ſome time reſolved; and an action diſhonourable to civil ſociety furniſhed him with too good a pretext for taking arms. The marquis del Guaſto, governor of the Milaneſe, having got intelligence of the motions and deſtination of two ambaſſadors, Rincon and Fergoſo, whom Francis had diſpatched, the one to the Ottoman Porte, the other to the republic of Venice; knowing how much his maſter wiſhed to diſcover the intentions of the French monarch, and of what conſequence it was to retard the execution of his meaſures, he employed ſome ſoldiers belonging to the garriſon of Pavia to lie in wait for theſe ambaſſadors as they ſailed down the Po, who murdered them and moſt of their attendants, and ſeized their papers. Francis immediately demanded reparation for this barbarous outrage; and as Charles endeavoured to put him off with an evaſive anſwer, he appealed to all the courts of Europe, ſetting forth the heinouſneſs of the injury, the iniquity of the emperor in diſregarding his juſt requeſt, and the neceſſity of vengeance. But Charles, who was a more profound negotiator, defeated in a great meaſure the effects of theſe repreſentations: he ſecured the fidelity of the Proteſtant princes in Germany, by granting them new conceſſions; and he engaged the king of England to eſpouſe his cauſe, under pretence

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pretence of defending Europe againſt the Infidels; while Francis was only able to form an alliance with the kings of Denmark and Sweden (who for the firſt time intereſted themſelves in the quarrels of the more potent monarchs of the ſouth), and to renew his treaty with Solyman, which drew on him the indignation of Chriſtendom.

But the activity of Francis ſupplied all the defects of his negotiation. Five armies were ſoon ready to take the field, under different generals, and with different deſtinations. Nor was Charles wanting in his preparations. He and Henry a ſecond time made an ideal diviſion of the kingdom of France. But as the hoſtilities which followed terminated in nothing deciſive, and were diſtinguiſhed by no remarkable event, except the battle of Ceriſoles (gained by Count d'Enguien over the imperialiſts, and in which 10,000 of the emperor's beſt

149 Peace concluded at Creſpy.

troops fell), at laſt Francis and Charles, mutually tired of haraſſing each other, concluded at Creſpy a treaty of peace, in which the king of England was not mentioned; and from being implacable enemies, became once more, to appearance, cordial friends, and even allies by the ties of blood.

The chief articles of this treaty were, that all the conqueſts which either party had made ſince the truce of Nice ſhould be reſtored; that the emperor ſhould give in marriage to the duke of Orleans, either his own eldeſt daughter, with the Low Countries, or the ſecond daughter of his brother Ferdinand, with the inveſtiture of the Milaneſe; that Francis ſhould renounce all pretenſions to the kingdom of Naples, as well as to the ſovereignty of Flanders and Artois, and Charles give up his claim to the duchy of Burgundy; and that both ſhould unite in making war againſt the Turks.

The emperor was chiefly induced to grant conditions ſo advantageous to France, by a deſire of humbling the Proteſtant princes in Germany. With the papal juriſdiction, he foreſaw they would endeavour to throw off the imperial authority; and he determined to make his zeal for the former a pretence for enforcing and extending the latter. However, the death of the duke of Orleans before the conſummation of his marriage, diſentangled the emperor from the moſt troubleſome ſtipulation in the treaty of Creſpy; and the French monarch, being ſtill engaged in hoſtilities with England, was unable to obtain any reparation for the loſs which he ſuffered by this unforeſeen event. Theſe hoſtilities, like thoſe between Charles and Francis, terminated in nothing deciſive. Equally tired of a ſtruggle attended with no glory or advantage to either, the contending princes concluded, at Campe, near Ardres, a treaty of peace; in which it was ſtipulated, that France ſhould pay the arrears due by former treaties to England. But theſe arrears did not exceed one-third of the ſums expended by Henry on his military operations; and Francis being in no condition to diſcharge them, Boulogne (a chargeable pledge) was left in the hands of the Engliſh as a ſecurity for the debt.

150 Charles obliged to conclude a diſadvantageous peace with the Turks and Proteſtants.

In conſequence of the emperor's reſolution to humble the Proteſtant princes, he concluded a diſhonourable peace with the Porte, ſtipulating that his brother Ferdinand ſhould pay tribute for that part of Hungary which he ſtill poſſeſſed; while the ſultan enjoyed the imperial and undiſturbed poſſeſſion of all the reſt. At the ſame time he entered into a league with Pope Paul III. for the extirpation of hereſy; but in reality with a view to oppreſs the liberties of Germany. Here, however, his ambition met with a ſevere check; for though he was ſucceſsful at firſt, he was obliged in 1552 to conclude a peace with the Proteſtants on their own terms; as has been related under the article REFORMATION, N° 26—3[illegible].

151 Attempts to recover [illegible] provinces.

By the peace concluded on this occaſion the emperor loſt Metz, Toul, and Verdun, which had formed the barrier of the empire on that quarter; and therefore ſoon after put himſelf at the head of an army, in order to recover theſe three biſhoprics. In order to conceal the deſtination of his army, he gave out, that he intended to lead it into Hungary, to ſecond Maurice in his operations againſt the Infidels; and as that pretext failed him, when he began to advance towards the Rhine, he propagated a report that he was marching firſt to chaſtiſe Albert of Brandenburg, who had refuſed to be included in the treaty of Paſſau, and whoſe cruel exactions in that part of Germany called loudly for redreſs.

152 Is obliged to raiſe the ſiege of Metz.

The French, however, were not deceived by theſe arts. Henry immediately gueſſed the true object of Charles's armament, and reſolved to defend his conqueſts with vigour. The defence of Metz, againſt which it was foreſeen the whole weight of the war would be turned, was committed to Francis of Lorraine, duke of Guiſe, who poſſeſſed in an eminent degree all the qualities that render men great in military command. He repaired with joy to the dangerous ſtation; and many of the French nobility, and even princes of the blood, eager to diſtinguiſh themſelves under ſuch a leader, entered Metz as volunteers. The city was of great extent, ill fortified, and the ſuburbs large. For all theſe defects the duke endeavoured to provide a remedy. He repaired the old fortifications with all poſſible expedition, labouring with his own hands; the officers imitated his example; and the ſoldiers, thus encouraged, cheerfully ſubmitted to the moſt ſevere toils; he erected new works, and he levelled the ſuburbs with the ground. At the ſame time he filled the magazines with proviſions and military ſtores, compelled all uſeleſs perſons to leave the place, and laid waſte the neighbouring country; yet ſuch were his popular talents, as well as his arts of acquiring an aſcendant over the minds of men, that the citizens not only refrained from murmuring, but ſeconded him with no leſs ardour than the ſoldiers in all his operations—in the ruin of their eſtates, and in the havoc of their public and private buildings.

Meanwhile the emperor continued his march towards Lorraine, at the head of 60,000 men. On his approach Albert of Brandenburg, whoſe army did not exceed 20,000 withdrew into that principality, as if he intended to join the French king; and Charles, notwithſtanding the advanced ſeaſon, it being towards the end of October, laid ſiege to Metz, contrary to the advice of his moſt experienced officers.

The attention of both the beſiegers and the beſieged was turned for ſome time towards the motions of Albert, who ſtill hovered in the neighbourhood, undetermined which ſide to take, though reſolved to ſell his ſervice. Charles at laſt came up to his price, and he joined the imperial army. The emperor now flattered himſelf that nothing could reſiſt his force; but he found himſelf deceived. After a ſiege of almoſt 60 days, during

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ring which he had attempted all that was thought poſſible for art or valour to effect, and had loſt upwards of 30,000 men by the inclemency of the weather, diſeaſes, or the ſword of the enemy, he was obliged to abandon the enterpriſe.

153
Miſerable condition of his army.

When the French ſallied out to attack the enemy's rear, the imperial camp was filled with the ſick and wounded, with the dead and the dying. All the roads by which the army retired were ſtrewed with the ſame miſerable objects; who, having made an effort beyond their ſtrength to eſcape, and not being able to proceed, were left to periſh without aſſiſtance. Happily that, and all the kind offices which their friends had not the power to perform, they received from their enemies. The duke of Guiſe ordered them all to be taken care of, and ſupplied with every neceſſary; he appointed phyſicians to attend, and direct what treatment was proper for the ſick and wounded, and what refreſhments for the feeble; and ſuch as recovered he ſent home, under an eſcort of ſoldiers, and with money to bear their charges. By theſe acts of humanity, leſs common in that age, the duke of Guiſe completed that heroic character which he had juſtly acquired by his brave and ſucceſsful defence of Metz.

154
His further miſfortunes.

The emperor's miſfortunes were not confined to Germany. During his reſidence at Villach, he had been obliged to borrow 200,000 crowns of Coſmo de Medici; and ſo low was his credit, that he was obliged to put Coſmo in poſſeſſion of the principality of Piombino as a ſecurity for that inconſiderable ſum; by which means he loſt the footing he had hitherto maintained in Tuſcany. Much about the ſame time he loſt Sienna. The citizens, who had long enjoyed a republican government, roſe againſt the Spaniſh garriſon, which they had admitted as a check upon the tyranny of the nobility, but which they found was meant to enſlave them; forgetting their domeſtic animoſities, they recalled the exiled nobles; they demoliſhed the citadel, and put themſelves under the protection of France.

To theſe unfortunate events one ſtill more fatal had almoſt ſucceeded. The ſevere adminiſtration of the viceroy of Naples had filled that kingdom with murmuring and diſſatisfaction. The prince of Salerno, the head of the malecontents, fled to the court of France. The French monarch, after the example of his father, applied to the grand ſignior; and Solyman, at that time highly incenſed againſt the houſe of Auſtria on account of the proceedings in Hungary, ſent a powerful fleet into the Mediterranean, under the command of the corſair Dragut, an officer trained up under Barbaroſſa, and ſcarcely inferior to his maſter in courage, talents, or in good fortune. Dragut appeared on the coaſt of Calabria at the time appointed; but not being joined by the French fleet according to concert, he returned to Conſtantinople, after plundering and burning ſeveral places, and filling Naples with conſternation.

155
Is ſucceſsful in the Low Countries.

Highly mortified by ſo many diſaſters, Charles retired into the Low Countries, breathing vengeance againſt France: and here the war was carried on with conſiderable vigour. Impatient to efface the ſtain which his military reputation had received before Metz, Charles laid ſiege to Terouane; and the fortifications being in diſrepair, that important place was carried by aſſault. Heſdin alſo was inveſted, and carried in the ſame manner. The king of France was too late in aſſembling his forces to afford relief to either of theſe places; and the emperor afterwards cautiouſly avoided an engagement.

156
But not ſo in other places.

The imperial arms were leſs ſucceſsful in Italy. The viceroy of Naples failed in an attempt to recover Sienna; and the French not only eſtabliſhed themſelves more firmly in Tuſcany, but conquered part of the iſland of Corſica. Nor did the affairs of the houſe of Auſtria go on better in Hungary during the courſe of this year. Iſabella and her ſon appeared once more in Tranſylvania, at a time when the people were ready for revolt, in order to revenge the death of Martinuzzi, whoſe loſs they had ſeverely felt. Some noblemen of eminence declared in favour of the young king; and the baſhaw of Belgrade, by Solyman's order, eſpouſing his cauſe, in oppoſition to Ferdinand, Caſtaldo, the Auſtrian general, was obliged to abandon Tranſylvania to Iſabella and the Turks.

157
Marriage between Philip of Spain and Mary of England.
An. 1554.

In order to counterbalance theſe and other loſſes, the emperor, in 1554, concerted a marriage between his ſon Philip and Mary of England, in hopes of adding that kingdom to his other dominions. Meanwhile the war between Henry and Charles was carried on with various ſucceſs in the Low Countries, and in Italy much to the diſadvantage of France. The French, under the command of Strozzi, were defeated in the battle of Merciano; Sienna was reduced by Medicino, the Florentine general, after a ſiege of ten months; and the gallant Sienneſe were ſubjected to the Spaniſh yoke. Much about the ſame time a plot was formed by the Franciſcans, but happily diſcovered before it could be carried into execution, to betray Metz to the Imperialiſts. The father guardian, and twenty other monks, received ſentence of death on account of this conſpiracy; but the guardian, before the time appointed for his execution, was murdered by his incenſed accomplices, whom he had ſeduced; and ſix of the youngeſt were pardoned.

While war thus raged in Italy and the Low Countries, Germany enjoyed ſuch profound tranquillity, as afforded the diet full leiſure to confirm and perfect the plan of religious pacification agreed upon at Paſſau, and referred to the conſideration of the next meeting of the Germanic body. During the negociation of this treaty, an event happened which aſtoniſhed all Europe, and confounded the reaſonings of the wiſeſt politicians.

158
Charles reſigns his dominions to his ſon Philip.
An. 1556.

The emperor Charles V. though no more than 56, an age when objects of ambition operate with full force on the mind, and are generally purſued with the greateſt ardour, had for ſome time formed the reſolution of reſigning his hereditary dominions to his ſon Philip. He now determined to put it in execution. Various have been the opinions of hiſtorians concerning a reſolution ſo ſingular and unexpected; but the moſt probable ſeem to be, the diſappointments which Charles had met with in his ambitious hopes, and the daily decline of his health. He had early in life been attacked with the gout; and the fits were now become ſo frequent and ſevere, that not only the vigour of his conſtitution was broken, but the faculties of his mind were ſenſibly impaired. He therefore judged it more decent to conceal his infirmities in ſome ſolitude, than to expoſe them any longer to the public eye; and as he was unwilling

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to forfeit the fame, or loſe the acquiſitions of his better years, by attempting to guide the reins of government when he was no longer able to hold them with ſteadineſs, he determined to ſeek in the tranquillity of retirement, that happineſs which he had in vain purſued amidſt the tumults of war and the intrigues of ſtate.

In conſequence of this reſolution, Charles, who had already ceded to his ſon Philip the kingdom of Naples and the duchy of Milan, aſſembled the ſtates of the Low Countries at Bruſſels; and ſeating himſelf for the laſt time in the chair of ſtate, he explained to his ſubjects the reaſons of his reſignation, and ſolemnly devolved his authority upon Philip. He recounted with dignity, but without oſtentation, all the great things which he had undertaken and performed ſince the commencement of his adminiſtration. "I have dedicated (obſerved he), from the 17th year of my age, all my thoughts and attention to public objects, reſerving no portion of my time for the indulgence of eaſe, and very little for the enjoyment of private pleaſure. Either in a pacific or hoſtile manner, I have viſited Germany nine times, Spain ſix times, France four times, Italy ſeven times, the Low Countries ten times, England twice, Africa as often; and while my health permitted me to diſcharge the duty of a ſovereign, and the vigour of my conſtitution was equal in any degree to the arduous office of governing ſuch extenſive dominions, I never ſhunned labour, nor repined under fatigue; but now, when my health is broken, and my vigour exhauſted by the rage of an incurable diſtemper, my growing infirmities admoniſh me to retire; nor am I ſo fond of reigning, as to retain the ſceptre in an impotent hand, which is no longer able to protect my ſubjects. Inſtead of a ſovereign worn out with diſeaſes (continued he), and ſcarce half alive, I give you one in the prime of life, already accuſtomed to govern, and who adds to the vigour of youth all the attention and ſagacity of maturer years." Then turning towards Philip, who fell on his knees, and kiſſed his father's hand, "It is in your power (ſaid Charles), by a wiſe and virtuous adminiſtration, to juſtify the extraordinary proof which I give this day of my paternal affection, and to demonſtrate that you are worthy of the extraordinary confidence which I repoſe in you. Preſerve (added he) an inviolable regard for religion; maintain the Catholic faith in its purity; let the laws of your country be ſacred in your eyes; encroach not on the rights of your people; and if the time ſhould ever come when you ſhall wiſh to enjoy the tranquillity of private life, may you have a ſon to whom you can reſign your ſceptre with as much ſatisfaction as I give up mine to you." A few weeks after, he reſigned to Philip the ſovereignty of Spain and America; reſerving nothing to himſelf out of all theſe vaſt poſſeſſions but an annual penſion of 100,000 crowns.

Charles was now impatient to embark for Spain, where he had fixed on a place of retreat; but by the advice of his phyſicians, he put off his voyage for ſome months, on account of the ſeverity of the ſeaſon; and, by yielding to their judgment, he had the ſatisfaction before he left the Low Countries of taking a conſiderable ſtep towards a peace with France. This he ardently longed for; not only on his ſon's account, whoſe adminiſtration he wiſhed to commence in quietneſs, but that he might have the glory, when quitting the world, of reſtoring to Europe that tranquillity which his ambition had baniſhed out of it almoſt from the time that he aſſumed the reins of government.

The great bar to ſuch a pacification, on the part of France, was the treaty which Henry had concluded with the Pope; and the emperor's claims were too 159
numerous to hope for adjuſting them ſuddenly. A truce of five years was therefore propoſed by Charles; during which term, without diſcuſſing their reſpective pretenſions, each ſhould retain what was in his poſſeſſion; and Henry, through the perſuaſion of the conſtable Montmorency, who repreſented the imprudence of ſacrificing the true intereſts of his kingdom to the raſh engagements that he had come under with Paul, authoriſed his ambaſſadors to ſign at Vaucelles a treaty, which would inſure to him for ſo conſiderable a period the important conqueſt which he had made on the German frontier, together with the greater part of the duke of Savoy's dominions.

A truce of five years concluded with France.

The Pope, when informed of this tranſaction, was no leſs filled with terror and aſtoniſhment than rage and indignation. But he took equal care to conceal his fear and his anger. He affected to approve highly of the truce; and he offered his mediation, as the common father of Chriſtendom, in order to bring about a definitive peace. Under this pretext, he appointed Cardinal Rebibo his nuncio to the court of Bruſſels, and his nephew Cardinal Caraffa to that of Paris. The public inſtructions of both were the ſame; but Caraffa, beſides theſe, received a private commiſſion, to ſpare neither intreaties, promiſes, nor bribes, in order to induce the French monarch to renounce the truce and renew his engagements with the holy ſee. He flattered Henry with the conqueſt of Naples; he gained by his addreſs the Guiſes, the queen, and even the famous Diana of Poictiers, ducheſs of Valentinois, the king's miſtreſs; and they eaſily ſwayed the king himſelf, who already leaned to that ſide towards which they wiſhed to incline him. All Montmorency's prudent remonſtrances were diſregarded; the nuncio (by powers from Rome) abſolved Henry from his oath of truce; and that weak prince ſigned a new treaty with the Pope; which rekindled with freſh violence the flames of war, both in Italy and the Low Countries.

160
Quarrel betwixt the Pope and King Philip.

No ſooner was Paul made acquainted with the ſucceſs of this negotiation than he proceeded to the moſt indecent extremities againſt Philip. He ordered the Spaniſh ambaſſador to be impriſoned; he excommunicated the Colonnas, becauſe of their attachment to the imperial houſe; and he conſidered Philip as guilty of high treaſon, and to have forfeited his right to the kingdom of Naples, which he was ſuppoſed to hold of the holy ſee, for afterward affording them a retreat in his dominions.

Alarmed at a quarrel with the Pope, whom he had been taught to regard with the moſt ſuperſtitious veneration, as the vicegerent of Chriſt and the common father of Chriſtendom, Philip tried every gentle method before he made uſe of force. He even conſulted ſome Spaniſh divines on the lawfulneſs of taking arms againſt a perſon ſo ſacred. They decided in his favour; and Paul continuing inexorable, the duke of Alva, to whom

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Spain. the negotiations as well as the war had been committed, entered the ecclefiaftical ftate at the head of 10,000 veterans, and carried terror to the gates of Rome.

The haughty pontiff, though ftill inflexible and undaunted himfelf, was forced to give way to the fears of the cardinals, and a truce was concluded for 40 days. Mean time the duke of Guife arriving with a fupply of 20,000 French troops, Paul became more arrogant than ever, and banifhed all thoughts from his mind but thofe of war and revenge. The duke of Guife, however, who had precipitated his country into this war, chiefly from a defire of gaining a field where he might difplay his own talents, was able to perform nothing in Italy worthy of his former fame. He was obliged to abandon the fiege of Civetella; he could not bring the duke of Alva to a general engagement; his army perifhed by difeafes; and the Pope neglected to furnifh the neceffary reinforcements. He begged to be recalled; and France ftood in need of his abilities.

Philip, though willing to have avoided a rupture, was no fooner informed that Henry had violated the truce of Vaucelles, than he determined to act with fuch vigour, as fhould convince Europe that his father had not erred in refigning to him the reins of government. He immediately affembled in the Low Countries a body of 50,000 men, and obtained a fupply of 10,000 from England, which he had engaged in his quarrel; and as he was not ambitious of military fame, he gave the command of his army to Emanuel Philibert duke of Savoy, one of the greateft generals of that warlike age.

The duke of Savoy kept the enemy for fome time in fufpenfe with regard to his deftination; at laft he feemed to threaten Champagne; towards which the French drew all their troops; then turning fuddenly to the right, he advanced by rapid marches into Picardy, and laid fiege to St Quintin. It was deemed in thofe times a town of confiderable ftrength; but the fortifications had been much neglected, and the garrifon did not amount to a fifth part of the number requifite for its defence: it muft therefore have furrendered in a few days, if the admiral de Coligny had not taken the gallant refolution of throwing himfelf into it with fuch a body of men as could be collected on a fudden. This he effected in fpite of the enemy, breaking through their main body. The place, however, was clofely invefted; and the conftable Montmorency, anxious to extricate his nephew out of that perilous fituation, in which his zeal for the public had engaged him, as well as to fave a town of fuch importance, rafhly advanced to its relief with forces one half inferior to thofe of the enemy. His army was cut in pieces, and he himfelf made prifoner.

161 The French entirely defeated at St Quintin. An. 1557.

The cautious temper of Philip on this occafion faved France from devaftation, if not ruin. The duke of Savoy propofed to overlook all inferior objects, and march fpeedily to Paris, which, in its prefent confternation, he could not have failed to make himfelf mafter of; but Philip, afraid of the confequences of fuch a bold enterprife, defired him to continue the fiege of St Quintin, in order to fecure a fafe retreat in cafe of any difaftrous event. The town, long and gallantly defended by Coligny, was at laft taken by ftorm; but not till France was in a ftate of defence.

Philip was now fenfible that he had loft an opportunity which could never be recalled, of diftreffing his enemy, and contented himfelf with reducing Horn and Catelet; which petty towns, together with St Quintin, were the fole fruits of one of the moft decifive victories gained in the 16th century. The Catholic king, however, continued in high exultation on account of his fuccefs; and as all his paffions were tinged with fuperftition, he vowed to build a church, a monaftery, and a palace, in honour of St Laurence, on the day facred to whofe memory the battle of St Quintin had been fought. He accordingly laid the foundation of an edifice, in which all thefe were included, and which he continued to forward at vaft expence, for 22 years. The fame principle which dictated the vow directed the building. It was fo formed as to refemble a gridiron—on which culinary inftrument, according to the legendary tale, St Lawrence had fuffered martyrdom. Such is the origin of the famous Efcurial near Madrid, the royal refidence of the kings of Spain.

The firft account of that fatal blow which France had received at St Quintin, was carried to Rome by the courier whom Henry had fent to recal the duke of Guife. Paul remonftrated warmly againft the departure of the French army; but Guife's orders were peremptory. The arrogant pontiff therefore found it neceffary to accommodate his conduct to the exigency of his affairs, and to employ the mediation of the Venetians, and of Cofmo de Medici, in order to obtain peace. The firft overtures of this nature were eagerly liftened to by the Catholic king, who ftill doubted the juftice of his caufe, and confidered it as his greateft misfortune to be obliged to contend with the Pope. Paul agreed to renounce his league with France; and Philip ftipulated on his part, that the duke of Alva fhould repair in perfon to Rome, and after afking pardon of the holy father in his own name and in that of his mafter, for having invaded the patrimony of the church, fhould receive abfolution from that crime. Thus Paul, through the fuperftitious timidity of Philip, finifhed an unpropitious war not only without any detriment to the apoftolic fee, but faw his conqueror humbled at his feet: and fo exceffive was the veneration of the Spaniards in that age for the papal character, that the duke of Alva, the proudeft man perhaps of his time, and accuftomed from his infancy to converfe with princes, acknowledged, that when he approached Paul, he was fo much overawed, that his voice failed, and his prefence of mind forfook him.

162 Peace concluded.

163 Confequences of the war in Italy.

But though this war, which at its commencement threatened mighty revolutions, was terminated without occafioning any alteration in thofe ftates which were its immediate object, it produced effects of confiderable confequence in other parts of Italy. In order to detach Octavio Farnefe, duke of Parma, from the French intereft, Philip reftored to him the city of Piacentia and its territory, which had been feized by Charles V. and he granted to Cofmo de Medici the inveftiture of Sienna, as an equivalent for the fums due to him. By thefe treaties, the balance of power among the Italian ftates was poifed with more equality, and rendered lefs variable than it had been fince it received the firft violent fhock from the invafion of Charles VIII. and Italy henceforth ceafed to be the theatre on which the monarchs of Spain, France, and Germany, contended for fame and dominion. Their hoftilities, excited by new objects, ftained other regions of Europe with blood, and

Spain. and made other ftates feel, in their turn, the miferies of war.

164 The French unfuccefsful in the Low Countries. The duke of Guife, who left Rome the fame day that his adverfary the duke of Alva made his humiliating fubmiffion to the Pope, was received in France as the guardian angel of the kingdom. He was appointed lieutenant-general in chief, with a jurifdiction almoft unlimited; and, eager to juftify the extraordinary confidence which the king had repofed in him, as well as to perform fomething fuitable to the high expectations of his countrymen, he undertook in winter the fiege of Calais. Having taken that place, he next invefted Thionville in the duchy of Luxembourg, one of the ftrongeft towns on the frontiers of the Netherlands; and forced it to capitulate after a fiege of three weeks. But the advantages on this quarter were more than balanced by an event which happened in another part of the Low Countries. The marefchal de Termes governor of Calais, who had penetrated into Flanders and taken Dunkirk, was totally routed near Gravelines, and taken prifoner by Count Egmont. This difafter obliged the duke of Guife to relinquifh all his other fchemes, and haften towards the frontiers of Picardy, that he might there oppofe the progrefs of the enemy.

The eyes of all France were now turned towards the duke of Guife, as the only general on whofe arms victory always attended, and in whofe conduct as well as good fortune they could confide in every danger. His ftrength was nearly equal to the duke of Savoy's, each commanding about 40,000 men. They encamped at the diftance of a few leagues from one another; and the French and Spanifh monarchs having joined their refpective armies, it was expected that, after the viciffitudes of war, a decifive battle would at laft determine which of the rivals fhould take the afcendency for the future in the affairs of Europe. But both monarchs, as if by agreement, ftood on the defenfive; neither of them difcovering any inclination, though each had it in his power, to reft the decifion of a point of fuch importance on the iffue of a fingle battle.

165 Peace concluded between Henry and Philip. During this ftate of inaction, peace began to be mentioned in each camp, and both Henry and Philip difcovered an equal difpofition to liften to any overture that tended to re-eftablifh it. The private inclinations of both kings concurred with their political interefts and the wifhes of their people. Philip languifhed to return to Spain, the place of his nativity, and peace only could enable him, either with decency or fafety, to quit the Low Countries. Henry was now defirous of being freed from the avocations of war, that he might have leifure to turn the whole force of his government towards fuppreffing the opinions of the reformers, which were fpreading with fuch rapidity in Paris and the other great towns, that they began to grow formidable to the eftablifhed church. Court-intrigues confpired with thefe public and avowed motives to haften the negociation, and the abbey of Cercamp was fixed on as the place of congrefs.

While Philip and Henry were making thefe advances towards a treaty which reftored tranquillity to Europe, Charles V. whofe ambition had fo long difturbed it, but who had been for fome time dead to the world,

166 Death of Charles V. ended his days in the monaftery of St Juftus in Eftremadura, which he had chofen as the place of his retreat, as is particularly related under the article CHARLES V.

After the death of Charles, the kingdom of Spain foon loft great part of its confequence. Though Charles had ufed all his intereft to get his fon Philip elected emperor of Germany, he had been totally difappointed; and thus the grandeur of Philip II. never equalled that of his father. His dominions were alfo confiderably abridged by his tyrannical behaviour in the Netherlands. In confequence of this, the United Provinces revolted; 167

Revolt of the United Provinces. and after a long and bloody war obtained their liberty *. In this quarrel Elizabeth of England took part againft Philip, which brought on a war with Spain. The great loffes he fuftained in thefe wars exhaufted the kingdom both of men and money, notwithftanding the great fums imported from America. Indeed the difcovery of that country has much impoverifhed, inftead of enriching Spain; for thus the inhabitants have been rendered lazy and averfe to every kind of manufacture or traffic, which only can 168

Expulfion of the Moors, and its bad confequences to Spain. be a durable fource of riches and ftrength to any nation. The ruin of the kingdom in this refpect, however, was completed by Philip III. who, at the inftigation of the inquifition, and by the advice of his prime minifter the duke of Lerma, expelled from the kingdom all the Morefcoes or Moors, defcendants of the ancient conquerors of Spain. Thirty days only were allowed them to prepare for their departure, and it was death to remain beyond that time. The reafon for this barbarous decree was, that thefe people were ftill Mahometans in their hearts, though they conformed externally to the rites of Chriftianity, and thus might corrupt the true faith. The Morefcoes, however, chofe themfelves a king, and attempted to oppofe the royal mandate; but, being almoft entirely unprovided with arms, they were foon obliged to fubmit, and were all banifhed the kingdom. By this violent and impolitic meafure, Spain loft almoft a million of induftrious inhabitants; and as the kingdom was already depopulated by bloody wars, by repeated emigrations to America, and enervated by luxury, it now fank into a ftate of languor from which it has never recovered.

* See *United Provinces*.

169 Philip IV. An. 1621. The reign of Philip IV. the fucceffor of Philip III. commenced in 1621. He had not been long feated on the throne before the expiration of the 12 years truce which Philip III. had concluded with the United Provinces, again involved Spain in the calamities of war. The renewed conteft was carried on with vigour by both the contending powers, till in the year 1648 the Spanifh monarch was compelled to fign the treaty of Munfter, by which the United Provinces were declared free and

170 Final lofs of the United Provinces. independent. From this period the power of the Spanifh monarchy began to decline, as it had already been feverely fhaken by the lofs of Portugal.

171 Revolt of Portugal. An. 1640. This event took place in 1640, when the Portuguefe finally threw off the Spanifh yoke, and that country remained an independent kingdom, till the power of Bonaparte compelled its lawful monarch to abandon his European territories. Philip IV. alfo profecuted an unfuccefsful war with France. This war was terminated in 1659, and Philip died about fix years after.

172 Charles II. An. 1665. The new monarch, Charles II. was only four years old when he fucceeded to the throne. He was of a feeble conftitution, and a weak capacity. The war which had been occafioned by the revolt of Portugal, continued till the year 1668, when a peace was concluded, and the independence of that kingdom was acknowledged. Hoftilities had been renewed with France, but

Spain.

but greatly to the diſadvantage of the Spaniards, who loſt ſome of the richeſt and beſt fortified towns which they ſtill poſſeſſed in Flanders. The peace of Nimeguen between France and Spain was ſigned in the year 1678. Charles II. died in 1700, and with him ended the male line of the houſe of Auſtria; a dynaſty to which Spain owes leſs than to any other race of its monarchs.

Hiſtorians have been fond of repreſenting the dominion of the Auſtrian princes in Spain as productive of the greateſt glory and advantage to that kingdom. The reign of Charles V. may indeed be ſaid to have been a glorious reign; but little of its glory belonged to Spain, and the emperor certainly neglected her intereſts in advancing thoſe of his more favoured territories. The picture given by the Spaniſh hiſtorians of the ſtate of Spain at the acceſſion and during the reign of Philip II. fully evinces how little that kingdom had profited by the change in the line of its ſucceſſion. Agriculture was neglected; commerce was fettered by enormous duties, and the people were held in the chains of ignorance and ſuperſtition.

173
Acceſſion of the Houſe of Bourbon.
An. 1700.

Charles II. was ſucceeded by Philip V. duke of Anjou, and grandſon to Louis XIV. of France, who had been nominated heir to the Spaniſh throne by the late monarch. The tranſactions of the war which was ſoon declared againſt France and Spain, by England, Holland, and the empire, aſſiſted by Savoy, Portugal, and Pruſſia, have been already related under the article BRITAIN, from N° 345 to N° 371. The treaty of Utrecht, which terminated the differences between the principal contending powers, was ſigned in 1713, and in 1715 a permanent peace was concluded between Spain and Portugal. Hoſtilities, however, ſtill continued with Savoy and Sardinia, and in 1715 the iſland of Sardinia was taken by a Spaniſh fleet, and the year following another fleet belonging to the ſame nation invaded Sicily, but was defeated by the Britiſh admiral Byng. By a new treaty in 1720, Sardinia was given to the duke of Savoy, and Sicily to the emperor; and by the treaty of Seville, concluded in 1729, the duchies of Tuſcany, Parma, and Placentia, were ceded to Spain. In 1731, the Spaniſh king invaded Naples, took poſſeſſion of that kingdom, and conferred it on his ſon Don Carlos, in conſequence of which war was declared between Spain and the empire in 1733. At the end of that year the palace of Madrid was conſumed by fire, and all the archives relating to the Indies periſhed in the flames.

In 1739, hoſtilities were renewed between Spain and Britain, (ſee BRITAIN, N° 403); but the only ſucceſſes acquired by the latter power were the capture of Porto Bello by Admiral Vernon, and that of the Manilla galeon by Commodore Anſon. After a long and turbulent reign, Philip V. died in 1746.

174
Ferdinand VI.
An. 1746.

Ferdinand VI. a mild, prudent, and beneficent prince, reformed abuſes in the adminiſtration of juſtice, and management of the finances. He revived commerce, eſtabliſhed manufactures, and promoted the proſperity of his kingdom. In April A. D. 1755, Quito in South America was deſtroyed by an earthquake.

175
Charles III.
An. 1759.

Charles III. ſucceeded Ferdinand in 1759. The famous family compact was concluded at Verſailles, A. D. 1761, among the four kings of the houſe of Bourbon. The Engliſh, alarmed by the naval preparations of Spain, declared war in 1762 (ſee BRITAIN, N° 450), and took Havannah in the iſland of Cuba, and Manilla in the Eaſt Indies. Notwithſtanding this ſucceſs, peace was haſtily concluded at Fountainbleau, in November, by which the Havannah was reſtored. In 1767 the Jeſuits were expelled from Spain. An unſucceſsful expedition was concerted againſt Algiers, A. D. 1775, the particulars of which are related in M. Swinburne's Travels, letter v. In the war between Great Britain and her American colonies, Spain, by the intrigues of the French court, was prevailed on to take up arms in ſupport of the latter. At the concluſion of that calamitous war, Great Britain in a treaty with Spain, ceded to this power, Eaſt and Weſt Florida, and the iſland of Minorca. Charles died in 1788, and was ſucceeded by his ſecond ſon Charles Anthony prince of Aſturias, the eldeſt having been declared incapable of inheriting the crown.

176
Charles IV.
An. 1788.

Charles IV. had not long been ſeated on the throne before the portentous revolution in France involved Europe in a general ſcene of political and military conteſt. The king of Spain joined the general confederacy againſt the new republic, and in conſequence was numbered among the objects of its reſentment, by a declaration of war in 1793. The military operations of Spain, however, were extremely languid; and after two campaigns, in which ſhe might be ſaid to carry on rather a defenſive than offenſive war, againſt the republican armies (ſee FRANCE, N° 411), ſhe was compelled to conclude a treaty of peace, which was ſigned at Baſil on the 22d July 1795. By this treaty the French republic reſtored to the king of Spain all the conqueſts which ſhe had made from him ſince the commencement of hoſtilities, and received in exchange all right and property in the Spaniſh part of St Domingo.

177
Engages in the confederation againſt France
An. 1793.

178
War between Spain and Britain.
An. 1796.

This treaty was ſoon followed by a rupture with Great Britain. On 5th October 1796, the court of Spain publiſhed a manifeſto againſt this country, to which the court of London made a ſpirited reply; and about the ſame time was publiſhed a treaty of offenſive and defenſive alliance, which had been concluded about two months before, between the king of Spain and the French republic. In the war which followed between Spain and Great Britain, his Catholic majeſty could boaſt of but little honour or ſucceſs; and the French republic gained little from its new ally, but the contributions of money, which ſhe from time to time compelled him to advance. On the 14th of February 1797, a Spaniſh fleet of 27 ſail of the line was defeated by Sir John Jervis off Cape St Vincent (ſee FRANCE. N° 482); and four of the Spaniſh line of battle ſhips were left in the hands of the victors. From this time till the temporary termination of hoſtilities by the peace of Amiens in 1802, there is nothing remarkable in the tranſactions of Spain. An. 1797.

On the renewal of the war in 1803, Spain was again compelled, by the overbearing power of France, to take an active part againſt Great Britain, and fitted out a formidable fleet, which was united to a conſiderable naval force of the new-made emperor of the French. The Spaniſh declaration of war againſt Britain is dated at Madrid on the 12th of December 1804; and on the 21ſt of October 1805, the combined fleets of France and Spain were nearly annihilated by Lord Nelſon's deciſive victory off Cape Trafalgar. An. 1803. An. 1805.

After this terrible blow to the naval power of Spain, nothing

nothing of importance took place till 1808, when the deſigns of Bonaparte againſt the independence of Spain, which had been long ſuſpected, were openly avowed, in conſequence of a domeſtic diſpute, probably fomented by the emiſſaries of France, which took place between Charles IV. and the prince of Aſturias. During the winter of 1807-8 the public mind in Spain had been greatly agitated. Some accuſed the prince of the Peace, Don Manuel Godoy, (who had long held the helm of ſtate, and was the richeſt and moſt powerful ſubject in the kingdom), of having concerted with the queen to deſtroy the prince of Aſturias. Others accuſed the prince of Aſturias of being at the head of a party to dethrone his father. Solemn councils and long proceedings, followed up by exiles and violent acts, far from calming opinions, ſerved to agitate them ſtill more.

179 Revolution in favour of the prince of Aſturias. An. 1808.

In March 1808, ſeveral diſturbances happened at Aranjuez. Theſe diſturbances were excited by a report that the royal family were about to quit Spain and emigrate to America. In conſequence of this report, the populace of the neighbouring villages repaired in crowds to Aranjuez, where they found the attendants of the court packing up the baggage of the royal houſehold; and underſtood that relays of horſes were ſtationed on the road to Seville, and that every thing was prepared for the departure of the royal fugitives, who were to take ſhipping at that port. It was ſuſpected that Don Manuel Godoy, or, as he has commonly been called, the prince of the Peace, was the chief inſtigator of this unpopular meaſure; and the fury of the people was directed chiefly againſt that nobleman, whoſe palace they attacked on the 18th of March. He, however, found means to eſcape for the preſent, but was afterwards arreſted in a garret of his own houſe. In the mean time the king iſſued two decrees with a view to allay the popular ferment; but as this ſtill continued, he on the 19th took the extraordinary reſolution of abdicating the throne in favour of the prince of Aſturias. This reſolution was made known by a royal decree, in which Charles declared that, as his natural infirmities no longer permitted him to ſupport the weight of government, and the re-eſtabliſhment of his health required a change of climate, he had after the moſt mature deliberation reſolved to abdicate his crown in favour of his heir the prince of Aſturias; and this reſolution he declared to be the reſult of his own free will.

180 Ferdinand VII.

The new ſovereign was accordingly proclaimed by the title of Ferdinand VII. and iſſued an edict confiſcating the effects of Don Manuel Godoy, and announcing the appointment of the duke of Infantado, a nobleman deſervedly popular for his talents and virtues, to the preſidency of Caſtile and the command of the royal guards.

Theſe diſturbances have commonly been attributed to the machinations of the French emperor, who had gained a complete aſcendency over the weak Charles; and had rendered the prince of the Peace entirely ſubſervient to the views which he had formed on the independence and the liberties of Spain. How far this ſuppoſition is correct, it is impoſſible for us at this time to determine; but it is rendered probable by the active meaſures taken about this time by Napoleon to awe by a French force the Spaniſh nation. Murat the grand duke of Berg was at this time on his march towards the capital with a body of French troops; and his march was haſtened by the information which he had received of the tumults at Aranjuez. This general cauſed it to be intimated to Ferdinand, that the emperor of the French was on his journey to Spain, and adviſed him to meet his maſter on the road. In the mean time he was tampering with the ſelf-depoſed monarch, whom he aſſured of the aſſiſtance of Bonaparte in reinſtating him on the throne. Charles accordingly addreſſed a letter to Bonaparte, in which he contradicts the aſſertion of his decree of the 19th; and declares that his abdication was a meaſure of compulſion; and throws himſelf on the protection of that great monarch, his friend and ally, from whom alone he and his ſubjects can hope to derive tranquillity and happineſs. 181

Deſigns of Bonaparte on the independence of Spain.

It appears to have been the deſign of Murat to draw out of Spain the whole of the royal family, and in this deſign he completely ſucceeded. Ferdinand ſet out to meet Bonaparte, accompanied by the French general Savary, and had advanced as far as Vittoria, where he was left by Savary, and where he found himſelf ſurrounded by French troops. He was compelled to remain at Vittoria, until Savary, who had proceeded to Bayonne, where Bonaparte then was, ſhould return and intimate to him the pleaſure of his maſter. When the general returned, he brought with him a letter from Napoleon to Ferdinand. In this letter, which is addreſſed to Ferdinand as prince of Aſturias, and not as king of Spain, Bonaparte aſſured the prince, that the ſole object of his journey into Spain was to make ſuch reforms in that kingdom as would be agreeable to the public feelings. Without pretending to judge reſpecting the late revolution, he cautions Ferdinand againſt the danger to be apprehended from ſovereigns permitting their ſubjects to take juſtice into their own hands. After inſinuating his own power over the royal family of Spain, and adverting to the tumults that had taken place, in which ſome of his troops had fallen, he makes uſe of the following expreſſion, "a few of my ſoldiers may be murdered; but the ſubjugation of Spain ſhall be the conſequence of it."

Ferdinand confounded at the conduct of the French emperor, and alarmed for his own perſonal ſafety, was compelled to proceed on his journey. When he arrived at Bayonne he was received by the prince of Neufchatel and Duroc, and was conducted to a place by no means ſuited to his rank or his character as ally of Bonaparte. He however dined with the emperor; but after he had retired, General Savary brought a meſſage from his maſter, intimating his determination that the preſent royal family of Spain ſhould give up to him all right and title to the crown of that kingdom, and that they ſhould be ſucceeded by a branch of his own family. Aſtoniſhed at this intimation, Ferdinand ſent his prime miniſter Cevallos, to canvaſs the matter with M. Champagny, the confidential ſecretary of Napoleon. The conference was held in an apartment adjoining the cabinet of the emperor, and, as it appeared, within his hearing: for when Cevallos was arguing with great warmth and ſtrength of reaſoning on the injuſtice and even impolicy of the propoſed meaſures, both he and Champagny were ordered into the emperor's preſence; and the former was reviled in the groſſeſt terms, branded with the appellation of a traitor, accuſed of having maintained that the recognition of Bonaparte was not neceſſary to the validity of his maſter's title to the throne of Spain, and of

 having

Spain. having affirmed that if the French dared to attack the independence of the Spanish monarchy, three hundred thousand men would rise to defend it and repel the invaders. After Napoleon had thus indulged the violence of his temper, he entered in a harsh and arrogant style on a discussion of the points in dispute between his secretary and Cevallos; and finding that he could neither convince nor silence the Spanish minister, he abruptly concluded with the following peremptory declaration: "I have a system of policy of my own; you ought to adopt more liberal ideas, to be less susceptible on the point of honour, and not sacrifice the prosperity of Spain to the interest of the House of Bourbon." From this time the destiny of the Spanish royal family was fixed. Ferdinand the monarch of the people's choice was already a captive, and not many days elapsed before the rest of the royal family was in the same situation. On the first of May, Ferdinand had made a conditional renunciation of his crown in favour of his father, and on the fifth of the same month Bonaparte had a long conversation with Charles the fourth and his queen. Ferdinand was called in by his father, to hear, in the presence of him and the queen, the disgusting and humiliating expressions which were uttered by the French emperor, expressions of such a nature, that Cevallos says he dares not record them. All the parties were seated except Ferdinand; he was ordered by his father to make an absolute renunciation of the crown, on pain of being treated as an usurper and a conspirator against the right of his parents. With this requisition Ferdinand complied, and thus completed the abdication of his family; for it appeared that on the preceding day Charles had executed the deed of resignation, which transferred to the emperor of the French his title to the crown of Spain, on consideration of receiving during his life an annuity of eighty millions of reals, of a dowry to his queen of two millions of reals, and to the infantes of Spain the annual sum of four hundred thousand livres.

Thus had Bonaparte effected the transference of the Spanish nation from the Bourbon dynasty to his own family, so far at least as that transference could be effected by the formal renunciation in his favour of the royal family, and by a strong but suspicious recommendation from them to the Spanish nation to receive their new sovereign, whoever he should be, with submission and obedience. Filled as the annals of mankind are with examples of treachery, perfidy, and violence, it would be difficult to point out a deed which in every part of its performance, in its own nature, or in the character of the means by which it was effected, bears such strong marks of unjust and lawless tyranny.

It was soon understood that Napoleon designed the crown of Spain for his brother Joseph, who had some time before been placed on the throne of Naples. In an address to the Spanish nation, which Bonaparte published immediately after the abdication of Charles and Ferdinand, he informed them that he did not mean to reign over them in person, but that he would give them a sovereign every way resembling himself. In the beginning of June Joseph Bonaparte arrived in the neighbourhood of Bayonne, where he was received by a deputation of the grandees of Spain and from the council of Castile, and presented with a congratulatory address, written in the most fulsome style of adulation, on his accession to the Spanish throne.

But though the nomination of Joseph Bonaparte was easily effected, it was not so easy to place him on the throne in opposition to the almost unanimous will of the Spanish nation. Ferdinand the seventh was the darling of the people; and his accession to the crown had been hailed by them, both as placing them under the dominion of a beloved monarch, and as releasing them from the tyranny of Godoy, who was an object of almost universal detestation. They had hitherto submitted with patience to the influence and power of France, hopeless of rescuing themselves while Charles possessed the throne, and while the prince of the Peace directed his councils; but the accession of Ferdinand, and the consequent disgrace of the favourite, had led them to hope that they should now find a sovereign willing to direct and assist their efforts to regain their independence. Under these expectations, a great part of the nation had come forward to offer their assistance in supporting the claims of the new monarch. The province of Catalonia, the most industrious and the most warlike of the Spanish nation, particularly distinguished itself by the promptitude and extent of its offers. Soon after Ferdinand had ascended the throne, the captain-general of Catalonia, relying on the well known resources and dispositions of the inhabitants, had come forward with an offer of a military force of above a hundred thousand men; and other provinces would have followed this example, but Ferdinand had discouraged these military preparations, and appeared willing to submit quietly to French bondage.

182
Opposed by a general insurrection of the Spaniards.

The spirit which had animated the Spaniards thus boldly to support their favourite sovereign, was not of a nature to be chilled and repressed by his timidity or example. The hatred which they had conceived against the French daily found fresh sources of nourishment. They saw Ferdinand, who had rejected their proffered services lest he should expose himself to the suspicion or displeasure of Bonaparte, enticed by deceit, or compelled by violence, to relinquish his kingdom and commit himself to the power of his enemy. They anticipated the consequences, and prepared to resist them with vigour and unanimity. The renunciation of the royal family in favour of Bonaparte was no sooner known in Spain, than the northern provinces burst into open insurrection. Asturias and Gallicia set the glorious example; and it was soon followed by almost every part of Spain, not immediately occupied or overawed by the armies of France.

One of the first steps taken by the leaders of the insurrection was, to assemble the juntas or general assemblies of the provinces. When these were organized, they issued proclamations, calling on the Spaniards to rise in defence of their sovereign, and in the assertion of their own independence. Besides these proclamations from the provincial juntas, addresses were published in almost every province by the leaders of the popular cause; in particular, the province of Aragon was addressed by Palafox, a name celebrated in the annals of the Spanish revolution, in a bold and spirited manifesto. The junta of Seville, which assembled on the 27th of May, formed itself into a supreme junta of government, caused Ferdinand to be proclaimed king of Spain, took possession of the military stores, and issued an order for all males from 16 to 45, who had not children, to enroll themselves in the national armies.

It was natural that, when entering on so determined an an oppofition to the meafures of Bonaparte, the Spaniards fhould turn their eyes towards that nation, by whom alone the ambitious views of that potentate had been fuccefsfully combated. A peace and alliance with Britain was evidently not only a meafure of policy, but would afford them the moft effectual affiftance in the formidable ftruggle in which they were about to engage. Accordingly, deputies were difpatched to Great Britain from feveral of the provinces, to folicit the aid and friendfhip of that country, and to concert meafures with the Britifh miniftry for executing the plans which had been contrived for freeing the kingdom from the French yoke. The junta of Seville iffued a declaration of war with France, and declared the Spanifh nation on terms of peace and amity with Britain. The Spanifh deputies were empowered to folicit fupplies of arms, ammunition, clothing and money; but it was thought that a fupply of Britifh troops would be unneceffary, the Spanifh patriots confidering themfelves as fully equal to the defence of their country. The caufe of the Spanifh patriots was eagerly embraced by the court of London, and by the Britifh nation at large, and the moft active meafures were quickly taken to fend them effectual aid.

183 Peace and alliance with Britain.

184 Statement of the French and Spanifh forces.

While thefe preparations were making on the part of the Spaniards, the French forces were collecting in great numbers, both on the frontiers, and in the neighbourhood of the capital. Above 25,000 men, under the command of Beffieres and Laffoles, threatened the provinces of Afturias and Bifcay, or occupied the plains of Caftile. Ten thoufand men were fhut up in the citadel of Barcelona; and to relieve them, a ftrong body of French troops had marched from the frontiers, and laid fiege to Zaragoza. A confiderable body under General Moncey attacked the city of Valencia; while the grand duke of Berg, after having detached General Dupont at the head of 20,000 men, to quiet the infurrection of the fouthern provinces, held Madrid with about 15,000 troops. Junot, with about 25,000 men, had entered Portugal, and taken poffeffion of the capital. The whole French force at this time in Spain cannot be computed at lefs than 100,000 men. Thefe were oppofed by a very numerous, but undifciplined force, commanded by generals of acknowledged bravery, but differing widely from each other in experience and military prudence. General Palafox commanded in Aragon; General Caftanos in the fouthern provinces; and General Blake in the north.

185 Succeffes of the Spanifh patriots.

The firft exertions of the Spanifh patriots were eminently fuccefsful, though they have been greatly exaggerated in the newfpapers publifhed under authority of the juntas. The harbour of Cadiz, which contained a numerous and well-appointed fleet, was under the command of the marquis de Solano, a man notorioufly attached to the French intereft; and here lay a French fleet, confifting of five fhips of the line and a frigate. One of the firft efforts of the patriots was, to obtain poffeffion both of Cadiz and the French fleet, and in this they completely fucceeded. Solano was arrefted and put to death, and Don Morla was appointed in his room. In the beginning of June the French fleet was fummoned to furrender, and on the admiral's refufal, was furioufly attacked by the batteries on fhore, and obliged to capitulate. The force detached by Murat, under Dupont, was attacked near Baylen, on the 22d July, by Major-general Reding, fecond in command under Caftanos, and after having been defeated, was compelled to furrender at difcretion. The French force befieging Zaragoza, was repeatedly attacked by General Palafox, and fuffered confiderable loffes, while that city held out with the moft heroic bravery. Perhaps there are few inftances in the annals of modern warfare, in which fuch perfevering and fuccefsful courage has been difplayed, as by the defenders of Zaragoza. All the means of attack which were in poffeffion of the French, directed by the fkill with which their long experience and fuccefs had fupplied them, were made ufe of. The inhabitants were obliged continually to be upon their guard, and to be prepared to refift the moft unexpected and fecret, as well as the moft open and violent affaults. The city was frequently bombarded in the middle of the night, at the fame time that the gates were attempted to be forced, under cover of the fhells. More than once the French got into fome parts of the town; but they were received with fo much coolnefs and bravery, that they were never able to preferve what they had with fo much difficulty and lofs acquired. The women vied with their hufbands, fons, and brothers, in the difplay of patriotifm and contempt of danger: regardlefs of the fire of the enemy, they rufhed into the very middle of the battle, adminiftering fupport and refrefhment to the exhaufted and wounded, and animating, by their exhortations and example, all ranks to fuch a difplay of firmnefs and bravery as long fecured this important city. When it is recollected, that the attacks of the French were numerous and varied, that they were conftantly repeated with frefh, and generally with increafing forces, and that the fole defence of the city refted with its fpirited inhabitants and the army of Palafox; fome idea may be formed of the difficulties they muft have undergone and furmounted, and of the glory to which they are fo juftly entitled. The patriots had gained poffeffion of moft of the fea ports in the bay of Bifcay, and headed by the bifhop of St Andero, repulfed the French in feveral attacks. The French force under General Moncey was alfo repulfed before Valencia, and the patriots were equally fuccefsful in feveral other quarters; fo that by the end of July there did not remain above 40,000 French forces within the Spanifh territory.

186 Arrival and flight of Jofeph Bonaparte.

In the meantime preparations were making at Madrid for the reception of the new fovereign Jofeph; and Murat, under pretence of ill health, quitted the capital, to give way to the brother of his mafter. Jofeph Bonaparte arrived at Madrid in the latter end of July, with a guard of 10,000 men; but foon after his arrival the news of the defeat and capitulation of Dupont reached Madrid, and threw the new court into the utmoft confternation. They underftood that the victorious army of Caftanos was on its march towards the capital; and if he did not fpeedily retire from fo dangerous a pofition, King Jofeph dreaded either falling into the hands of the conqueror of Dupont, or of being intercepted in his retreat by the army of General Blake. In this fituation he found himfelf under the neceffity of quitting the capital which he had fo lately entered, and before the end of the month he had reached Burgos in his precipitate flight towards the frontiers. Thus, within the fpace of two months, did the people of Spain behold their country almoft entirely freed from the prefence of the French; and this glorious and happy iffue had been brought about by their own intrepidity. At a time when their fituation was the moft difpiriting and forlorn;

Spain. lorn; when their king had been compelled to forfake them, and to make over his right to the throne to a foreign potentate; when they beheld fcarcely any troops furrounding them on all fides, but thofe of that potentate, they rofe in arms, and oppofed themfelves, unfkilled as they were in war, and totally unprepared for it, to a man before whom the mightieft empires in Europe had fallen.

187 Reverfes. The fucceffes of the Spanifh arms, though brilliant and important, were but tranfient. The leaders of the infurrection appear to have been but ill calculated to oppofe the fyftem of tactics which had been fo often practifed with fuccefs by the conqueror of Marengo, of Jena, and of Aufterlitz. Though the conquefts of Auftria and Pruffia had been effected by the fame fyftem which the French were now purfuing in Spain, the military men of this kingdom were incapable of analyzing them, or of adopting effectual meafures of oppofition or defence. In a feries of about 30 bulletins, publifhed from the French army of Spain, comprehending from the beginning of November 1808 to the middle of January 1809, we read of nothing but the rapid movements and fucceffes of the French, and the defeat and annihilation of the beft appointed armies of the infurgents. In Gallicia, General Blake, after having withftood the duke of Dantzick (Marfhal Ney), in feveral encounters, was at length defeated, and his army difperfed. A divifion of the army of Eftremadura, under Count Belvider, which had marched from Madrid to fupport the city of Burgos, was attacked and defeated by a divifion of the French army under the dukes of Iftria and Dalmatia; while the army of General Caftanos was in a great meafure difperfed, after a fevere conflict on the heights of Tudela. According to the French account, the army of Caftanos confifted of 45,000 men. It was oppofed by the duke of Montebello, and entirely defeated, with the lofs of nearly 4000 killed, and 5000 taken prifoners.

In the meantime Bonaparte had entered Spain, and taken the command of the French army. He advanced by rapid marches towards Madrid, and at the end of November his advanced guard reached the important pafs of Somofierra. This pafs was defended by a body of 13,000 Spaniards, with fixteen pieces of cannon. They were attacked by the French under the duke of Belluno, and after making a confiderable ftand, were entirely defeated. On the 2d of December Bonaparte arrived in the neighbourhood of Madrid, and on the 5th he was mafter of that capital.

188 Britifh expeditions in fupport of the Spanifh patriots. While the Spanifh patriots were thus purfuing their plan of oppofition to French tyranny with various fuccefs, the Britifh cabinet were fitting out formidable expeditions to the coafts of Spain and Portugal. The refult of the expedition under Sir Harry Burrard and Sir Arthur Wellefley, the battle of Vimiera, the convention of Cintra, and the confequent evacuation of Portugal by the French, in the month of Auguft 1808, have been already noticed under Portugal, N° 49 and 50. After thefe tranfactions, the greater part of the Britifh army under the command of Lieutenant-general Sir John Moore, proceeded on their march to the frontiers of Spain. The progrefs and operations of this army will be detailed mentioned. About the middle of the fame month, a body of 13,000 Britifh troops, under the command of Sir David Baird, arrived at Corunna, and proceeded through the interior of the country, intending to join Sir John Moore in the neighbourhood of Madrid. A brigade of 10,000 men under General Hope, reached that capital, and eftablifhed themfelves at the Efcurial; but on the approach of Bonaparte, were under the neceffity of retiring.

189 March of Sir John Moore to Sahagun. Experience has fhown that in their military campaigns on the continent, Britifh forces have to contend with numerous difficulties, furmountable only by the utmoft prudence and vigilance on the part of the commanding officers, and by a confiderable degree of fkill and forefight on that of the projectors of fuch undertakings. Never perhaps were thefe difficulties more feverely felt than in the march of Sir John Moore from Portugal to the centre of the Spanifh territory. It was found that in whatever direction he might profecute his march, he would encounter either bad roads or fcanty fupplies of provifions. In particular, the difficulty of tranfporting the artillery over the Portuguefe mountains was extreme; and the Portuguefe at Lifbon were either egregioufly ignorant of the ftate of the roads which led through their own country to the Spanifh frontiers, or were unwilling to communicate the information which they really poffeffed. Under thefe circumftances it was found neceffary to divide the Britifh army; and it was determined to fend forward one divifion confifting of 6000 men under the command of Lieutenant-General Hope, which was directed to march by Elvas, to enter Spain by Badajos, and to proceed along the Madrid road by way of Efpinar. Another divifion, confifting of two brigades under General Paget, was detached by way of Elvas and Alcantara, where it was to pafs the Tagus. Two brigades under General Beresford moved through Portugal by way of Coimbra and Almeyda towards Salamanca, while three brigades under General Frafer marched towards the frontiers of Spain by Abrantes and Almeyda.

Burgos had been recommended by the Spanifh government as the point of union for the Britifh troops, and Madrid and Valladolid were appointed for magazines. The Britifh had been led to expect that they would find between 60,000 and 70,000 Spaniards affembled under General Blake and the marquis de la Romana in the provinces of Afturias and Gallicia, and that a much greater number was ready to co-operate with them under the command of Caftanos on the front and left of the principal French pofition. The Spaniards had been reprefented as unanimous in their enthufiafm for the caufe of liberty, and as ready to treat the Britifh troops as the faviours of their country. How far this information was correct, will be feen prefently.

In marching through the Portuguefe territory, the troops firft encountered difficulties which they were not prepared to expect. The contractor at Lifbon, who had agreed to fupply the divifions with rations on the march, failed in his contract, and exceffive inconvenience was experienced from the want of money. The divifions under Generals Frafer and Berefford were obliged to halt, and it was fome time before they could again fet forward. The proceedings of the central junta, on which all the movements both of the Britifh and Spanifh armies chiefly depended, were languid, tardy, and irrefolute; and before the Britifh troops could affemble in any force in Spain, the principal armies of the patriots had been defeated and difperfed in almoft

every

Spain. every quarter. On the 8th of November Sir John Moore reached Almeyda. The weather was at this time extremely unfavourable, and the troops were exposed to almost incessant rain. They entered Spain on the 11th of November, and on the 13th Sir John arrived with his advanced guard at Salamanca, where he halted, intending to assemble there all the troops which were on their march through Portugal. While he remained at Salamanca, he was informed that a considerable French force had advanced and taken possession of Valladolid, at the distance of only twenty leagues, by which one of the places that had been intended for magazines was lost. At this time Sir John had with him only three brigades of infantry without artillery, and it would be at least ten days before the whole of the divisions could come up. He was thus exposed to almost an immediate attack by the French without any effectual support from the boasted patriotism of the Spaniards.

The situation of affairs in Spain had now become extremely critical; and every account sent to Sir John Moore by men of sound judgement, was filled with convincing proofs that the Spanish government had concealed from their ally the very desperate state of their affairs. General Hope, by a long and tiresome march, had reached the neighbourhood of Madrid, whence he wrote a letter to Sir John, stating that every branch was affected by the disjointed and inefficient construction of the government. On the 28th of November Sir John was advertised of the late defeat and dispersion of Castanos, and of the little probability there was of his being able to march forward, so as to effect any thing of advantage. He therefore determined to fall back, though this determination was evidently in opposition to the wishes and advice of his officers. Fresh dispatches, however, from the seat of government, diminishing the losses which had been sustained by the patriots, and exaggerating the ardour with which the people were actuated, induced him to delay his retreat, especially as he had now a complete, though small corps, with cavalry and artillery, and could, by a movement to the left, easily effect a junction with Sir David Baird, while the division under General Hope had, by rapid marches, arrived in the neighbourhood of Salamanca.

In addition to the misrepresentations by which the commanders of the British forces, and the British envoy at Aranjuez, had been deceived, they had now to contend with two designing men, who, it soon appeared, were in the French interest. These were Don Morla, the late governor of Cadiz, and a M. Charmilly. By the machinations of these men, Mr Frere was led to advise, and Sir John Moore strongly incited to undertake, bringing the whole of the British force to the neighbourhood of Madrid, where they would soon have been completely within the power of the enemy. Though by these arts Sir John was effectually misled, he did not suffer himself to be drawn into so dangerous a snare. He, however, advanced beyond Salamanca, and sent forward the reserve and General Beresford's brigade towards Toro on the Douro, where they were to unite with the cavalry under Lord Paget, who had advanced thither from Astorga. On December 12th, Lord Paget, with the principal part of the cavalry, marched from Toro to Tordesillas, while the brigade under General Stewart moved from Arivolo. In the vicinity of Tordesillas, near the village of Rueda, the British forces were first opposed by the French, a small party of whom were attacked and defeated.

While Sir John Moore was at Toro, he received intelligence that the duke of Dalmatia was at Saldana with a considerable body of French troops, that Junot, duke of Abrantes, was marching with another towards Burgos, and that a third under the duke of Treviso was destined for Zaragoza. He was very desirous that the first of these generals should advance to meet him, and with this view he had come forward to Toro, which he reached on the 16th of December. He had hoped for effectual assistance from the corps commanded by the marquis de la Romana, but he soon found that this general could render him no support. He had now resolved to threaten the communication between France and Madrid; and, if a favourable opportunity offered, to attack the duke of Dalmatia's corps, or any of the covering divisions that should present themselves. He foresaw that this would necessarily draw upon him a large French force, and of course would prove an important diversion in favour of the Spaniards; who would by this means have the opportunity of collecting in the south, and restoring their affairs. The army was now near the French position. The cavalry under Lord Paget were pushed so forward, that their patrols reached as far as Valladolid, and had frequent succesful skirmishes with the enemy. Colonel Otway met a detachment of French cavalry, charged them, and made the whole prisoners.

On the 18th of December, Sir John's head-quarters were at Castro Nuevo, and Sir David Baird's at Benevente, on the road to join him. On the 20th Sir John reached Majorga, where he was joined by Sir David Baird. The united British army now amounted to rather fewer than 26,000 men, of whom about 2000 were cavalry. The weather was extremely cold, and the ground covered with deep snow. Still the exertions of the troops were indefatigable, and the cavalry in particular attacked and defeated a considerable body of French horse. On the 21st the army reached Sahagun, where Sir John established his head-quarters, and determined to halt for some time, to refresh his troops, after the fatigues which they had undergone.

Sir John had now arrived within a very short distance from Saldana, where the duke of Dalmatia was posted, with the flower of the French army; and preparations were made for an attack, which was waited for with all the ardour and impatience which distinguish British troops. In the mean time, however, repeated couriers arrived at head-quarters, the bearers of unpleasant intelligence. Certain information was received, that a strong French reinforcement had arrived at Carrion, a little to the right of Sahagun, that the French corps, which was marching to the south, had halted at Talavera, and that the enemy were advancing from Madrid in considerable force. Sir John now saw that his motions had been watched by Bonaparte, and that all the arts of this experienced general had been preparing to entrap him. To advance was madness; to retreat, almost in the face of an enemy, was a measure of the utmost danger, but it was the only alternative. 120

His retreat. On the 24th of December Sir John began silently and secretly to prepare for his retreat, and to provide, as far as possible, for the defence of those parts of the country

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country which were ftill held by the patriots. With this latter view, he directed Sir David Baird to take the route towards Valencia de Don Juan, while the reft of the army was to proceed by Caftro Gonzalo. By this divifion the magazines and ftores which had been depofited at Benevente and Zamora, were alfo effectually fecured.

According to the arrangement made, General Frafer, followed by General Hope, marched with their divifions on the 24th December to Valderos and Majorga, and Sir David Baird proceeded with his to Valencia. To conceal this movement, Lord Paget was ordered to pufh on ftrong patrols of cavalry clofe to the advanced pofts of the enemy. The referve, with two light corps, did not retire from Sahagun till the morning of the 25th, following General Hope. Lord Paget was ordered to remain with the cavalry until evening, and then follow the referve. Thefe laft were accompanied by Sir John. The retreat commenced in this deliberate manner. On the 26th of December, Sir David Baird reached the Eflar, and paffed the ferry with lefs difficulty than was expected. He took poft, according to his orders, at Valencia, and wrote to the marquis of Romana, urging him to blow up the bridge of Manfilla. The other divifions of infantry proceeded unmolefted to Caftro Gonzalo. On the 24th the advanced guard of Bonaparte's army marched from Tordefillas, 120 miles from Madrid, and ftrong detachments of cavalry had been pufhed forward to Villalpando and Majorga. On the 26th, Lord Paget fell in with one of thofe detatchments at the latter place. His lordfhip immediately ordered Colonel Leigh, with two fquadrons of the 10th huffars, to attack this corps, which had halted on the fummit of a fteep hill. One of Colonel Leigh's fquadrons was kept in referve; the other rode brifkly up the hill; on approaching the top, where the ground was rugged, the colonel judicioufly reined-in to refrefh the horfes, though expofed to a fevere fire from the enemy. When he had nearly gained the fummit, and the horfes had recovered their breath, he charged boldly and overthrew the enemy; many of whom were killed and wounded, and above 100 furrendered prifoners. Nothing could exceed the coolnefs and gallantry difplayed by the Britifh cavalry on this occafion. The 18th dragoons had fignalized themfelves in feveral former fkirmifhes; they were fuccefsful in fix different attacks. Captain Jones, when at Palencia, had even ventured to charge 100 French dragoons with only 30 Britifh; 14 of the enemy were killed, and fix taken prifoners. The cavalry, the horfe-artillery, and a light corps, remained on the night of the 26th, at Caftro Gonzalo; and the divifions under Generals Hope and Frafer marched to Benevente. On the 27th, the rear guard croffed the Eflar, and followed the fame route, after completely blowing up the bridge.

We fhall not attempt any farther detail of this dangerous and calamitous retreat, in which our army fuffered extremely, from the fatigues of conftant marching, from the badnefs of the weather, and even from the brutality of the Spaniards, in whofe caufe they had embarked. Before they reached Aftorga, it was found neceffary to divide the army. A body of 3000 men, under Brigadier-general Crawford, was detached on the road to Orenfe towards Vigo, while the main body, under the command of Sir John Moore, marched by Aftorga and Lugo, on the road to Corunna. They left Aftorga on the 30th of December, and on the 11th of January came in fight of Corunna. The army had now reached the fea port from which they were to embark, but adverfe winds had detained the tranfports, or the whole of the troops would have been fpeedily and fafely on board. Only a few fhips lay in the harbour, and in thefe fome fick men and a few ftragglers, under pretence of ficknefs, had immediately embarked.

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Clofely followed by the French.

During the whole march from Sahagun to Corunna, the Britifh army was clofely followed by the French, under Bonaparte and the duke of Dalmatia; and the two armies were often fo near each other, that the French patrols fell in, during the night, with the cavalry piquets of the Britifh. The duke of Dalmatia had joined Bonaparte at Aftorga, and had increafed his force to nearly 70,000 men, while the whole force of the Britifh did not exceed 26,000. When Sir John's army reached Lugo, it was found that three divifions of the French were arranged in front, and it was thought advifable, on the 8th of January, to offer the enemy battle. This offer, however, the French thought proper to decline, and the duke of Dalmatia ftirred not from his poft. When the army reached Corunna, the French were far in the rear, and it was hoped that the tranfports might arrive before the enemy could come up.

The retreat of the Britifh, confidering the circumftances under which it was effected, was a brilliant and fuccefsful achievement. Two hundred and fifty miles of country had been traverfed in 11 days, during the worft feafon of the year, through bad roads, over mountains, defiles, and rivers, and in almoft daily contact with an enemy nearly three times their numbers. Though often engaged, the rear guard of the Britifh had never been beaten, nor even thrown into confufion. Many loffes had indeed been fuftained, in baggage, artillery, and horfes, and many ftragglers had fallen into the hands of the enemy; but neither Napoleon nor the duke of Dalmatia could boaft of a fingle military trophy taken from the retreating army. The greateft danger was ftill to be incurred; the pofition of Corunna was found to be extremely unfavourable; the tranfports had not arrived, and the enemy began to appear upon the heights. The fituation of the army was by moft of the officers thought fo defperate, that they advifed the general to propofe terms to the duke of Dalmatia, that they might be fuffered to embark unmolefted; but this advice Sir John, without hefitation, rejected.

On the 12th of January, the French were feen moving in confiderable force on the oppofite fide of the river Mero. They took up a pofition near the village of Perillo, on the left flank of the Britifh, and occupied the houfes along the river. In the mean time Sir John was inceffantly occupied in preparing for the defence of his poft, and in making every arrangement for the embarkation of the troops. 192

Pofition of the army.

On the 13th, Sir David Baird marched out of Corunna with his divifion, and took poft on a rifing ground, where he determined to remain all night. A divifion under General Hope was fent to occupy a hill on the left, which commanded the road to Betanzos, forming a femicircle with Sir David Baird's divifion on the right. General Frazer's divifion was drawn up near the road to Vigo, about half a mile from Corunna, and communicated

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communicated with that under Sir David Baird, by means of the rifle corps attached to the latter, which formed a chain acrofs the valley. The referve under Major-general Paget occupied a village on the Betanzos road, about half a mile from the rear of General Hope. The higher grounds on the rear and flanks of the Britifh were poffeffed by the French, a fituation which gave the latter a confiderable advantage.

In the evening the tranfports from Vigo hove in fight; but the enemy was now fo near, and had, during this day, fhown fo much difpofition to moleft the Britifh, that a general action was become inevitable. On the 15th, the enemy had advanced to a height where, the day before, a magazine, containing nearly 4000 barrels of gun powder, had been blown up, and which was immediately oppofite to the pofition of the Britifh. On this day fome fkirmifhes took place.

193 Battle of Corunna.

On the 16th, every thing was prepared for a general action. Moft of the artillery had been embarked, as it was found that, from the nature of the ground, much artillery could not be employed with advantage. During the 13th and 14th, the fick, the difmounted cavalry and horfes, were alfo nearly all embarked. On the morning of the 16th, the French on the hills were apparently quiet, and it was hoped that the embarkation might be effected in the courfe of that night; but about noon the enemy, who had in the morning received reinforcements, and had placed fome guns in front of the right and left of his line, was obferved to be getting under arms, to be moving troops towards his left flank, and forming various columns of attack at that extremity of the ftrong and commanding pofition which he had taken on the 15th, in front of the Britifh line. This indication of his intention was immediately fucceeded by a rapid and determined attack on the divifion under Sir David Baird, which formed the right wing, and was the weakeft part of the line. The firft effort of the enemy was met by Sir John Moore and Sir David Baird at the head of the 42d regiment, and the brigade under Lord William Bentinck. The village on the right became an object of obftinate conteft. While leading on his divifion to fupport this pofition, Sir David had his arm fhattered with a grape fhot.

Not long after, while Sir John Moore was riding from poft to poft, everywhere encouraging his troops, and pointing out the moft advantageous opportunities for attack or defence, his confpicuous fituation had expofed him to the fire of the enemy. A cannon-ball ftruck his left fhoulder, and beat him to the ground. He raifed himfelf, and fat up with an unaltered countenance, looking intently at the Highlanders, who were warmly engaged. Captain Hardinge threw himfelf from his horfe, and took him by the hand; then, obferving his anxiety, he told him the 42d were advancing, upon which his countenance immediately brightened. His friend Colonel Graham now difmounted to affift him; and, from the compofure of his features, entertained hopes that he was not even wounded: but obferving the horrid laceration and effufion of blood, he rode off for furgeons. The general was carried from the field on a blanket, by a fergeant of the 42d, and fome foldiers. On the way he ordered Captain Hardinge to report his wound to General Hope, who affumed the command. Many of the foldiers knew that their two chiefs were carried off: yet they continued to fight with undiminifhed courage; and, by the moft determined bravery, not only repelled every attempt of the enemy to gain ground, but actually forced him to retire, though he had brought up frefh troops in fupport of thofe originally engaged.

The enemy finding himfelf foiled, in every attempt to force the right of the pofition, endeavoured by numbers to turn it. A judicious and well-timed movement, which was made by Major-general Paget, with the referve, which corps had moved out of its cantonments to fupport the right of the army, by a vigorous attack, defeated this intention. The major-general having pushed forward the 95th (rifle corps) and 1ft battalion 52d regiment, drove the enemy before him; and, in his rapid and judicious advance, threatened the left of the enemy's pofition. This circumftance, with the pofition of Lieutenant-general Frafer's divifion (calculated to give ftill farther fecurity to the right of the line) induced the enemy to relax his efforts in that quarter. They were, however, more forcibly directed towards the centre, where they were again fuccefsfully refifted by the brigade under Major-general Manningham, forming the left of Sir David Baird's divifion, and a part of that under Major-general Leith, forming the right of the divifion under General Hope. Upon the left the enemy at firft contented himfelf with an attack upon our picquets, which, however, in general, maintained their ground. Finding, however, his efforts unavailing on the right and centre, he feemed determined to render the attack on the left more ferious, and had fucceeded in obtaining poffeffion of the village through which the great road to Madrid paffes, and which was fituated in front of that part of the line. From this point, however, he was foon expelled with confiderable lofs, by a gallant attack of fome companies of the 2d battalion of the 14th regiment, under Lieutenant-colonel Nicholls. Before five in the evening, the Britifh had not only fuccefsfully repelled every attack made upon the pofition, but had gained ground in almoft all points, and occupied a more forward line than at the commencement of the action, whilft the enemy confined his operations to a cannonade, and the fire of his light troops, with a view to draw off his other corps. At fix the firing ceafed. The different brigades were reaffembled on the ground which they occupied in the morning, and the picquets and advanced pofts refumed their original ftations.

Notwithftanding the decided and marked fuperiority which at this moment the gallantry of the troops had given them over an enemy, who, from his numbers and the commanding advantages of his pofition, no doubt expected an eafy victory, General Hope did not, on reviewing all circumftances, conceive that he fhould be warranted in departing from what he knew was the previous and fixed determination of the late commander of the forces, to withdraw the army on the evening of the 16th, for the purpofe of embarkation, the previous arrangements for which had already been made by his order, and were in fact far advanced at the commencement of the action. The troops quitted their pofition about 10 at night, with a degree of order that did them credit. The artillery that remained unembarked, having been withdrawn, the troops followed in the order prefcribed, and marched to their refpective points of embarkation in the town and neighbourhood of Corunna. The picquets remained at their pofts till five in the

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the morning of the 17th, when they were alfo withdrawn with fimilar order, and without the movement having been difcovered by the enemy.

By the unremitted exertion of the captains of the royal navy, who had been entrufted with the fervice of embarking the army, and in confequence of the arrangements made by the agents for tranfports, the whole of the forces were embarked with an expedition which has been feldom equalled. The brigades under Major-generals Hill and Beresford were deftined to remain till daylight, in order to watch the movements of the enemy. The brigade under General Beresford, which was alternately to form the rear-guard, occupied the land in front of Corunna, while that under General Hill was ftationed on the promontory in the rear of the town by way of referve.

The enemy pufhed his light troops towards the town, foon after eight o'clock in the morning of the 17th, and fhortly after occupied the heights of St Lucia, which commanded the harbour But notwithftanding this circumftance, and the manifold defects of the place, there being no apprehenfion that the rear-guard could be forced, and the difpofition of the Spaniards appearing to be good, the embarkation of Major-general Hill's brigade was commenced and completed by three in the afternoon. After having fully explained, to the fatisfaction of the Spanifh governor, the nature of the movement, and having made every previous arrangement, General Beresford withdrew his corps from the land in front of the town foon after dark, and was, with all the wounded that had not previoufly been removed, fafely embarked before one o'clock of the morning of the 18th.

In this action the Britifh troops had come off with glory, and there can be no doubt, frcm the repulfe of the French forces, and their fubfequent inactivity, that the honour of the victory belonged to the Britifh. The victory had indeed coft them dear. They had loft one of their beft generals; and probably nearly 1000 men had been killed or wounded during the action. It had been achieved at the termination of a long and haraffing fervice. The fuperior numbers, and advantageous pofition of the enemy, not lefs than the actual fituation of the Britifh army, did not admit of any advantage being reaped from fuccefs. The luftre of the Britifh arms had, however, been maintained under the moft difadvantageous circumftances. The army which had entered Spain amidft the faireft profpects, had no fooner completed its junction, than owing to the multiplied difafters that difperfed the native armies around it, it was left to its own refources. The advance of the Britifh troops from the Douro afforded the beft hope, that the fouth of Spain might be relieved; but this generous effort to fave an unfortunate people, alfo afforded the enemy the opportunity of directing every effort of his numerous troops, and concentrating all his principal refources for the deftruction of the only regular force in the north of Spain. Thefe circumftances had produced the neceffity of rapid and haraffing marches, which had diminifhed the numbers, exhaufted the ftrength, and impaired the equipment of the army. Notwithftanding all thefe difadvantages, and thofe more immediately attached to a defenfive pofition, which the imperious neceffity of covering the harbour of Corunna, for a time, had rendered indifpenfible to affume, the native and undaunted valour of Britifh troops was never more confpicuous.

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At daybreak on the 18th, the Englifh convoy was under fail, and on the 19th it had entirely left the Spanifh coafts.

194 Second expedition under Sir Arthur Wellefley.

Notwithftanding the ill fuccefs which had thus attended the expedition under Sir John Moore, the fpirit of patriotifm which appeared ftill to actuate the fouthern provinces of Spain, and the hope that the common caufe might there be fupported to greater advantage, induced the Britifh miniftry to fend another military force to the weftern peninfula of Europe, to co-operate with the patriots who ftill continued in arms. Accordingly, a body of about 15,000 forces, under the command of Sir Arthur Wellefley, whofe bravery and good conduct in the battle of Vimiera, had recommended him, in a particular manner, both to the miniftry and the nation, was difpatched towards the coaft of Portugal, where Marfhal Beresford ftill maintained a Britifh force; while General Hill, with about 5000 infantry, and 400 cavalry, failed from Ireland with the fame deftination. General Hill arrived at Lifbon on the 4th of April, and foon after Sir Arthur landed with the main body. On the 7th of April the army moved forward towards the Douro, and croffed that river during the night of the 11th, a little above Oporto. Here they fell in with a French detachment from the army of the duke of Dalmatia, which they routed and put to flight, after a fhort but well-contefted action.

After this action the duke of Dalmatia found it neceffary to retreat. He paffed through the defiles of Salamonde, and thus gained confiderably on the Britifh army, though he was obliged to leave behind him part of his artillery. On the 19th of May he was at Allaritz, and on the 20th he continued his retreat acrofs the Minho, which he paffed at Orenfe, thus leaving Portugal once more in poffeffion of the Britifh forces.

Sir Arthur Wellefley, after having remained for fome time in the Portuguefe territory, to refrefh his men after the fatigues which they had undergone, advanced into Spain, and effected a junction with General Cuefta, who then commanded a confiderable part of the remains of the patriotic army. In the latter end of July, the allied army had advanced to Talavera de la Reyna, in the neighbourhood of which they were encountered by a formidable French force, confifting of a corps commanded by Marfhal Victor, another under General Sebaftiani, the guards of Jofeph Bonaparte, amounting to 8000 men, and the garrifon of Madrid. This large force was commanded by Jofeph Bonaparte in perfon, affifted by Marfhals Jourdan and Victor, and General Sebaftiani.

195 Battle of Talavera.

On the 27th of July, an attack was made by the French army on that of the allies, who had taken up their pofition at Talavera. The attack was vigorous, but was repelled with great fpirit and fuccefs, though not without confiderable lofs on the part of the Britifh.

The defeat of this attempt was followed about noon of the 28th by a general attack of the enemy's whole force, on the whole of that part of the pofition which was occupied by the Britifh army. The general attack began by the march of feveral columns of infantry into the valley, with a view to attack the height occupied

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by Major-general Hill. These columns were immediately charged by the 1st German light dragoons, and 23d dragoons, under the command of General Anson, and supported by General Fane's brigade of heavy artillery; and although the 23d dragoons suffered considerable loss, the charge had the effect of preventing the execution of that part of the enemy's plan. At the same time an attack was directed upon Brigadier-general Alexander Campbell's position in the centre of the combined armies, and on the right of the British. This attack was most successfully repulsed by Brigadier-general Campbell, supported by the king's regiment of Spanish cavalry, and two battalions of Spanish infantry; and the allies were left in possession of the enemy's cannon.

An attack was also made at the same time on Lieutenant-general Sherbrooke's division, which was on the left and centre of the first line of the British army. This attack was most gallantly repulsed by a charge with bayonets, by the whole division; but the brigade of guards which were on the right, having advanced too far, were exposed on their left flank to the fire of the enemy's battery, and of their retiring columns; and the division was obliged to retire towards the original position, under cover of the second line of General Cotton's brigade of cavalry, which had moved from the centre, and the 1st battalion 48th regiment. This regiment was removed from its original position on the heights, as soon as the advance of the guards was perceived, and formed in the plain; it advanced upon the enemy, and covered the formation of Lieutenant-general Sherbrooke's division. Shortly after the repulse of this general attack, in which apparently all the enemy's troops were employed, he commenced his retreat across the Alberche, which was conducted in the most regular manner, and effected during the night, leaving in the hands of the British 20 pieces of cannon, ammunition, tumbrils, and some prisoners.

Though the French were defeated in this engagement, and, according to Sir Arthur Wellesley's account, must have lost at least 10,000 men, the loss of the British was very great. By the official returns it is stated to exceed 5000, namely, in killed, 34 officers, 28 sergeants, 2 drummers, and 735 rank and file; in wounded 195 officers, 165 sergeants, 16 drummers, and 3537 rank and file; and in missing 9 officers, 15 sergeants, 9 drummers, and 620 rank and file. The action, though brilliant, does not appear to have been attended with much advantage to the allies, as, from the reinforcements which the French army was daily receiving, Sir Arthur Wellesley (now Lord Wellington) was soon compelled to fall back towards the frontiers of Portugal, leaving behind him much of his baggage, and the whole of his sick and wounded. It must be recorded to the honour of the French commander, into whose hands these unfortunate men had fallen, that, in consequence of a representation in their favour by Lord Wellington, he treated them with the utmost humanity, and afforded them every accommodation which the nature of their situation admitted.

Since the battle of Talavera, nothing of importance has transpired respecting the state of affairs in Spain. It appears that the patriots still continue to make a stand against their invaders; but it cannot be expected that their opposition shall be ultimately attended with success. The resources of the French are so numerous and extensive, and the force which he is able to draw towards the Spanish peninsula, has been so much increased in consequence of the peace lately concluded between France and Austria, that the liberties of Spain must, we fear, fall a sacrifice, and that kingdom must contribute to swell the already exorbitant power of the house of Bonaparte.

196 Summary view of Spanish history.

We shall conclude the historical part of this article with a summary recapitulation of the principal revolutions which have taken place in Spain.

From the year 240 B. C. to the year 206 B. C. Spain was in some degree under the dominion of the Carthaginians. From the year 206 B. C. to the commencement of the fifth century of the Christian era, it continued almost entirely in possession of the Romans. The Goths reigned in Spain from the year 411 to 711; the Moors from the year 711 till 716, in part of the Asturias; till 820 in Catalonia; till 750 in Sobrarba; till 923 in Leon; till 1073 in different parts of the two Castiles; till 1118 in Aragon; till 1236 in Cordova and Jaen; till 1248 in Seville; till 1264 in the kingdom of Valencia; till 1265 in that of Murcia; and even so late as 1492 in Granada. During the wars against the Moors, the Goths reigned in the Asturias, Gallicia, and, finally, in the kingdom of Leon till 1038.

The house of Navarre, descended from the French house of Bigorre, which had previously reigned in Castile for 10 years, united with it the crown of Leon till the year 1126. This was succeeded by the family of Bourbon, descended from the royal family of France, which reigned over these countries till 1555. The house of Charlemagne, a French family descended from that prince, ruled over Catalonia from the year 802 till 1132. The French family of Bigorre first reigned in Sobrarba, and afterwards in Aragon, from the year 750 to 1162; at that period the French family of Barcelona succeeded to the government, and united to the crown of Aragon that of Catalonia, and afterwards the kingdom of Valencia, over which it reigned till the year 1430. These parts of Spain then came into the possession of the princes of the French branch of Navarre, which reigned in Castile, and continued in their descendants to 1515; at which time the different states of the Spanish monarchy were united under the government of Joanna the Foolish, who reigned over them till her death, which happened in 1555. The Austrian family then possessed the throne till 1700, since which time it has been occupied by a branch of the house of Bourbon, till the late revolution, by placing the Spanish monarchs in the power of the French, has given rise to a new dynasty of princes in the person of Joseph Bonaparte.

197 Antiquities.

The earliest Spanish antiquities which can be with certainty ascertained, belong to the Roman period; and of these the examples are extremely numerous. They abound in the provinces of Catalonia, Valencia, and those which border on the Pyrenees. We cannot here enumerate, much less describe, all the remains of Roman antiquity mentioned by Swinburne, Townsend, De Laborde, and other travellers in Spain. The most remarkable are, the aqueduct at Segovia, in Old Castille, consisting of 159 arches, extending about 740 yards, and being at least 94 feet high, where it crosses the valley; the amphitheatre of the ancient *Saguntum*, near the

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the modern Morviedro in Valencia, which was hewn out of the folid rock, and appears to have been capable of containing 10,000 fpectators; a fuperb Roman arch, fupported by Corinthian pillars, and having a very lofty gateway, not far from Tarragona; a monument near the fame place, fuppofed to be the tomb of the father and uncle of Scipio Africanus; and a confiderable amphitheatre on an eminence near Seville. It is fuppofed that the ancient city of Italica, built by Scipio Africanus for the reception of his wounded foldiers, ftood near this fpot; but we are affured by Mr Swinburne, that no traces of it now remain.

Of the Gothic edifices, no certain remains are to be found; but the Moorifh antiquities are numerous and fplendid. Of thefe, the moft remarkable are the palace of the Alhambra in the city of Granada, and the mofque of Cordova. Of the former we have already given an account under ALHAMBRA. The mofque, now the cathedral of Cordova, was begun by Abdoulrahman I. caliph of Cordova, and is computed to contain not fewer than 800 columns. The architecture of its doors, windows, and arches, efpecially thofe of the chapel of the Koran, at leaft equals that of the Alhambra in grandeur of defign, and beauty of execution, and exceeds that palace in variety of decoration. This fuperb edifice has been minutely defcribed by Mr Swinburne, in his travels into Spain, Letter 35. Not far from Cordova ftood the magnificent city of Zehra, built by Abdoulrahman III. and which is faid to have employed 25 years in building, and to have coft more than 2,500,000 l. of our prefent fterling money. In this city was a palace containing 1173 columns, of African, Spanifh, Italian, and Afiatic marbles. This fplendid palace, and the city in which it ftood, were entirely deftroyed during the wars by which Spain was defolated in the middle ages.

198 Population of Spain.

It has been computed, that under the dominion of the Romans, Spain contained a population of nearly 50,000,000 of people; but this calculation is, by De Laborde, diminifhed to 20,000,000.

At the clofe of the 14th century, the population is ftated by moft Spanifh writers as follows.

In the ftates of Caftile	11,000,000
States of Aragon,	7,700,000
Kingdom of Granada,	3,000,000
	21,700,000

On what De Laborde deems better authority, he reduces this number to 16,000,000.

In the reign of Ferdinand and Ifabella, at the end of the 15th century, the total population of Spain has generally been eftimated at 20,000,000, but this too is reduced by Laborde to 14,000,000 or 15,000,000.

The population was reduced

in 1688 to - - -	10,000,000
1700 - - - -	8,000,000
1715 - - - -	6,000,000
In 1768 it had rifen to - -	9,307,800
1788 - - - -	10,143,975

According to the table of the provinces, collected chiefly from De Laborde, it amounted, at the end of the 18th century, to 10,308,505; by the laft cenfus, taken in the years 1797 and 1798, the ftatements of which have not been publifhed, but were lately locked up in the office belonging to the minifter of finance, it appears that the population, at the end of the 18th century, exceeded 12,000,000.

From thefe ftatements we obferve, that the population of Spain had gradually diminifhed from its conqueft by the Romans, to the reign of Philip V. in the beginning of the 18th century; but that during the laft hundred years it has rapidly increafed.

Various caufes have been affigned for the remarkable depopulation that had taken place in the Spanifh dominions. Perhaps the following by Dr Playfair are fufficiently plaufible. "The peftilential fevers and epidemical difeafes, which carried off one-third of the inhabitants in the year 1347, and have produced great mortality during the two laft centuries; almoft inceffant ftruggles for dominion, from 714 till the conqueft of Granada, and union of the two crowns of Caftile and Aragon; the expulfion of about 400,000 Jews by Ferdinand and Ifabella, and of 900,000 Moors, A. D. 1610; the difcovery of South America in 1493, which has gradually drained the country of its inhabitants and its induftry; the calamities of war, during two centuries, from the acceffion of the emperor Charles V.; the form of government, and national prejudices, which difcourage foreigners from fettling in the kingdom, and are inimical to manufactures, commerce, and agriculture; the debauchery that prevails among all ranks; the great number of convents; the celibacy of the clergy; religious oppreffion, and numerous feftivals, which leffen the number of working days, and fo abridge the labour of the people."

Of the number above ftated, the clergy are reckoned at leaft 147,722: viz. of fecular clergy, 60,240; of monks 49,270; of nuns and friars, 22,337, and of fubaltern minifters of the church 15,875. The numbers of the clergy have indeed diminifhed by more than 27,000, during the laft 30 years of the 18th century, as in the year 1768 they amounted to 176,057.

199 Number of towns, villages, &c.

According to a calculation in the year 1776, the cities, towns, villages, and hamlets, amounted to 84459 (D); and public edifices and temples to 30,496.

It appears that there exift in Spain 2,628,557 individuals of both fexes, who do not contribute, or at leaft are not fuppofed to contribute, to the population. From this view, and the progrefs we have already ftated, it will be eafy to difcover, by comparative calculations with the detailed ftatements of population in other countries, the proportionate number of births, deaths, marriages, &c. which annually take place in Spain.

200 Government.

The Spanifh government, which was of a limited nature, during the dynafties of the kings of Caftile and Aragon, afterwards became an abfolute monarchy. At that

(D) In the year 1788, the number of villages was eftimated at 19,219; and that of parifhes at 20,080.

that period the royal prerogative was confined both by the expreſs tenor of the laws and the forms of their adminiſtration. The peculiar privileges of the two ſtates of Caſtile and Aragon continued to exiſt long after their reunion; but the royal authority was conſtantly taking umbrage at their exerciſe. The princes of the Auſtrian family did not openly attack them, but had recourſe to the more effectual method of ſecretly undermining them; and thus they were ſo far diminiſhed, that at the cloſe of the 17th century they amounted to little more than mere forms. The attachment of Aragon to the cauſe of the archduke Charles, induced the firſt ſovereign of the royal family of France to aboliſh them entirely. Philip V. having ſubdued Aragon, ſuppreſſed the ſtates-general, the laſt meeting having been held at Zaragoza in the year 1720, on which occaſion Queen Iſabella of Savoy preſided in the abſence of her huſband, who was at that time in Italy. Since that period no further power is left the *Cortez* of Caſtile and Aragon, but the privilege of nominating deputies to the ſtates-general of the kingdom, whenever they are ſummoned by the monarch.

The whole authority, previous to the late revolution, centred in the king and his miniſters; the national affairs were conducted by the different councils, appointed by the crown, which deliberated and formed their plans in the capital. Some of theſe poſſeſſed both legiſlative and executive power, and exerciſed the double function of adviſing the king and adminiſtering juſtice. The council of Caſtile, in this diſtribution of power, was paramount; its decrees being deciſive in the courts, but its judgements were under the controul of the king. The reſolutions were tranſmitted to the monarch by a certain number of members, under the title of the *Chamber of Caſtile*, whoſe influence was prodigiouſly great. This council was ſo denominated, becauſe the members choſen by the king formerly co-operated with miniſters in expediting the affairs of ſtate in the royal chamber, and for this purpoſe they attended the court wherever it was held.

Beſides the council of Caſtile, there was the royal and ſupreme council of the Indies, inveſted with the ſame powers, and exerciſing ſimilar functions with reſpect to the American colonies, as the council of Caſtile with reſpect to the European territory.

201
Revenues.

It is not eaſy to aſcertain the amount of the revenues under the late government. They aroſe from a tax on imports and exports; from the chief objects of internal conſumption; from the monopolies of the crown; from landed eſtates; from tythes of church and abbey lands; from the ſale of indulgences; and from the trade with the American colonies. Their total amount has been variouſly ſtated. M. Jordan has computed it to exceed 7,000,000l. ſterling; by M. De Laborde, the revenues for the European continent alone, are calculated to exceed 8,000,000l. ſterling.

202
Military ſtrength.

It would be abſurd to attempt any eſtimate of the military ſtrength of Spain in its preſent ſtate of diſorganization and confuſion. During the latter part of the 18th century, the land forces in time of peace ſeldom exceeded 50,000 ill-diſciplined troops; but in time of war, the army was capable of being augmented to a formidable force. In the year 1798 the ſtanding forces of the Spaniſh monarchy amounted to 100,000 effective men.

Till of late the Spaniſh navy was highly reſpectable, both as to ſtrength and diſcipline. In the year 1778 the Spaniſh fleet conſiſted of 148 veſſels of all deſcriptions; and of theſe more than 60 were ſhips of the line. In 1788, the number of ſhips of the line amounted to 68, and that of large frigates to 47. In the preſent long conteſt among the powers of Europe, the navy of Spain has been greatly diminiſhed; and the only fleet of any importance now exiſting is that in the harbour of Cadiz.

203
Orders of knighthood.

There are in Spain ſeveral orders of knighthood, or as they are called, military orders. The principal is that of the *Golden Fleece*, inſtituted in the year 1430, by Duke Philip the Good. The order of St Jago di Compoſtella was inſtituted by Ferdinand II. in the year 1175, and its badge is a red uniform croſs in twelve departments. The order of Calatrava, inſtituted by Sancho III. of Caſtile, has for its badge a red croſs in five departments. The order of Alcantara was inſtituted by Ferdinand II.; and its badge is a lily placed croſsways. The order of Monteſa, inſtituted in the year 1317, by James III. king of Aragon, is compoſed of 19 commanderies.

204
Coins.

The money of Spain is either real or imaginary, the former ſerving for the purpoſe of exchange, the latter for keeping accounts and tranſacting buſineſs. Both theſe are common through the whole kingdom; but ſeveral kinds of both are to be found in the different provinces.

Two kinds of real money, both in gold and ſilver, are diſtinguiſhed in Spain; the old, that is, ſuch as were coined before the year 1772, and thoſe coined ſubſequent to that period. None of the former are uniform, but conſiſt of ſmall pieces of different ſizes unequally cut, and their currency is only by weight. The latter uniformly bear the head of the ſovereign on the obverſe, and on the reverſe ſide the arms of Spain; the ancient gold coins are more intrinſically valuable than the modern. The laſt only will be here deſcribed.

Modern Gold Coins.

Coins.	Value in Sterling money.
Durito Eſcudo chico de oro Veniento de oro	- 4s. 2d. (E)
Eſcudo de oro Doblon ſenzillo	- - 8s. 4d.
Doblon de oro	- - 16s. 8d.
Doblon de quatre Medio doblon de a ocho Media onza de oro	1l. 13s. 4d.
Doblon de ocho Onza de oro	- 3l. 6s. 8d.

Modern

(E) In computing the value of the Spaniſh coins in ſterling money, we have employed M. De Laborde's tables; in which their value is eſtimated in money tournois, computing the livre tournois at 10d. ſterling, and the ſol at ½d. ſterling.

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Modern Silver Coins.

Coins.	Value in sterling money.
Real Real de vellon Medio real de plata	$2\frac{1}{2}$d.
Real de plata Media pecata	5d.
Pecata Real de a dos	10d.
Escudo Medio duro	2s. 1d.
Duro Pezoduro Real de à ocho	4s. 2d.

205 Weights and measures.

The Spanish weights and measures vary considerably in different parts of the kingdom, as almost every province has both peculiar to itself. The pound generally consists of 16 ounces in that part of the kingdom formerly belonging to the crown of Castile, and of 12 ounces in those annexed to the crown of Aragon; viz. in Aragon, in the kingdom of Valencia, and in Catalonia; but the ounce is not the same. We shall here only particularize the weights of Castile.

In the Castiles they reckon by charges, quintals, arobas, arreldes, pounds, ounces, and drams. The following table gives the proportional value of the Castilian weights.

		lb.	*oz.*
The charge contains	3 quintals	300	0
—— quintal	4 arobas	100	0
—— aroba	25 pounds	25	0
—— arrelde	4 pounds	4	0
—— pound	16 ounces	1	0
—— ounce	16 drams		1
—— dram	30 grains		$\frac{1}{16}$
—— grain			$\frac{1}{480}$

The measures are still more complicated than the weights; and especially the measures of capacity, will require to be considered rather more in detail. We shall, as usual, distinguish them into long measure, superficial or land measure, and measures of capacity.

Long measure.—The standard lineal measure in Spain is the royal foot, consisting of $153\frac{41}{100}$ lines; and bearing to the English foot the proportion of about 153 to 144, or of 17 to 16. This foot, however, is not in general use, almost every province having its own foot, which is generally rather less than the royal foot. Thus, the foot in Castile is 8 lines less, and that of Valencia about $9\frac{1}{2}$ lines less than the standard.

Of royal feet 100 are equivalent to 102 feet 7 inches of Catalonia, to 107 feet of Valencia, to 115 feet 10 inches and 4 lines of Castile.

One hundred feet of Catalonia are equal to 92 feet 2 inches 3 lines of the royal foot, to 97 feet $5\frac{1}{2}$ lines of Valencia, and 104 feet 11 inches 11 lines of Castile.

In Valencia 100 feet are equivalent to 93 feet 4 inches 10 lines of the royal foot, to 98 feet 9 inches of Catalonia; and 107 feet 2 inches 6 lines of Castile.

In Castile, 100 feet are equal to 86 feet 1 inch 5 lines of the royal foot; to 93 feet 4 inches $9\frac{1}{2}$ lines of Valencia; and 92 feet 2 inches 3 lines of Catalonia.

Cloths and stuffs in Catalonia are measured by *canas*, in other parts of the kingdom by *varas*; the cana is divided into 8 *pams*, the vara into four. The proportions which these bear to the royal foot will be seen from the following table:

	Feet.	Inches	Lines.
Pam of Catalonia, - -	0	7	4
Cana of Catalonia, - -	4	10	8
Six pams make the Paris ell.			
Pam of Castile, -	0	7	8
Vara of Castile, - -	2	6	8
Pam of the kingdom of Valencia,	2	9	4
Five pams and a little more than $\frac{1}{5}$th, or one vara one pam and a little more than $\frac{1}{5}$th, make a Paris ell.			
Pam of Aragon, - - -	0	6	$7\frac{3}{8}$
Vara of the Asturias, - -	2	5	9
Vara of Aragon, - - -	2	2	$5\frac{1}{2}$
A little less than 6 pams, or one vara two pams, make a Paris ell.			
Pam of Galicia for linen drapery,	0	9	2
Vara of Galicia for ditto, -	2	6	8

Land Measure.—Land in the provinces belonging to the crown of Castile is measured by *ungadas*, *fanegas*, *estadales*, *brasses*, *varas*, *pas*, and *aranzadas*. Of these the ungada contains 50 fanegas, about $204\frac{5}{10}$ feet; the fanega 400 estadales = about $4\frac{8}{100}$ feet; the estadale two brasses = about ten feet; the brass two varas, or about 5 feet 1 inch 4 lines; the pas about $1\frac{2}{3}$d of a vara, and the aranzada about 73 varas. This last is only used for measuring vineyards.

In Biscay land is measured by *carros*, *plazas*, and *celemines*; and in Valencia by *yugadas*, *cahizadas*, *fanegas*, *brasses*, and *pams*.

Measures of Capacity.—Corn is measured in the provinces belonging to the crown of Castile by *cahizas*, *fanegas*, *celemines*, and *quartillos*; and in Biscay the same measures are used, with the exception of the cahiza. The cahiza contains 12 fanegas, and is = about $1\frac{1}{2}$ lb. French; the fanega contains 12 celemines = 124 lb.; the celemine 4 quartillos = 10lb. $5\frac{1}{3}$ ounces, and the quartillo = 2 lb. $7\frac{1}{4}$ ounces.

In Catalonia grain is measured by *salmas*, *charges*, *quarteras*, *cortons*, and *picotis*. The salma contains 2 charges or 6 quintals = 546lb.; the charge contains 2 quarteras or 3 quintals = 273lb.; and the quartero 12 cortans or $\frac{1}{2}$ quintal = 136lb. 8 oz.: the cortan contains 4 picotis or 13 lb. of 12 oz. = 11 lb. 6 oz.; and the picoti $3\frac{1}{4}$lb. of 12 oz. = 2lb. $13\frac{1}{2}$ oz.

The measures for liquids vary exceedingly, according to the liquid they are intended to contain. Thus, at Madrid, honey is measured by *arobas* and *quartillos*, the quartillo being about $1\frac{1}{2}$lbs. and the aroba containing 32 *quartillos*. Oil is measured in New Castile also by arobas and quartillos, but the quartillo is $=6\frac{1}{4}$ lbs; and the aroba contains 4 quartillos, or 25 lbs. In Seville, oil is measured by the pipe and aroba, the pipe containing 34 arobas; while in Valencia it is measured by charges, arobas, and cantaros, the charge containing 12 arobas, and the cantaro equal 28 lbs. 1 oz.

Wine in New Castile is measured by moyos, an imaginary measure, cantaras, azumbres, quartillos, and sextarios.

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tarios. The moyo contains 16 cantaras, the cantara 12 azumbres, the azumbre 4 quartillos, each equal to 1 lb. At Cadiz wine is meafured by tonneaux, arobas, azumbres, and quartillos. The tonneau contains 30 arobas, the aroba 8 azumbres, the azumbre 4 quartillos, each of which is equal to 1 lb. 1 oz. At Sevilie the meafures for wine are cantaras, azumbres, and quartillos. The cantara contains 8 azumbres, the aroba the fame, the azumbre 4 quartillos, each of which is equal to 17 ounces. In Valencia thefe meafures are, botas or tonneaux, charges, arobas, or cantaras, and azumbres or cuentas; and in Catalonia, pipes, charges, quintals, arobas, quarteros, and quartos, of which the pipe contains 4 charges, the charge 3 quintals, the quintal 4 arobas, the aroba 22 quarteros, the quartero 4 quartos, and the quarto is equal to nearly 3 ounces of Catalonian meafure.

206 Laws.

The laws of Spain, which for a long time varied greatly in the different ftates of the monarchy, are at prefent reduced to a confiderable degree of uniformity. Navarre and Bifcay have retained their ancient laws and conftitution; but the revolution which took place in Spain at the beginning of the 18th century, enabled Philip V. to introduce into Catalonia and the kingdoms of Aragon and Valencia the laws of Caftile; which, excepting a few alterations, rendered neceffary by local peculiarities, ftill continue in full effect.

The laws of Caftile, which are thus become thofe of almoft all Spain, are contained in the codes known by the titles of the *Fuero juzgo*, *Ley de las fiete partidas*, *Ordenamiento real*, *Fuero real*, and *Recepilacion;* of thefe the laft is a collection of occafional edicts of the kings of Spain, and enjoys the higheft authority.

The Roman law has no validity in Spain, and though it may be ftudied by a few lawyers, as containing firft principles univerfally applicable; yet it is never quoted in the courts, and is exprefsly excepted againft by fome of the old laws of Caftile.

207 Adminiftration of juftice.

The conducting of a law fuit in Spain is fubject to very complicated forms; whence neceffarily refults a flownefs of progrefs. The whole bufinefs is carried on by writers, a peculiar branch of the legal profeffion. In the fuperior tribunals, the management of caufes is in like manner committed to a kind of fubaltern magiftrates, called reporters (*relatores*), who contrive to render their own department a fituation of much greater emolument than that of the judge.

In all the branches of civil, military, ecclefiaftical, and judicial adminiftration, in Spain, is evident a fpirit of mildnefs and paternal indulgence, which often degenerates into great abufe. By multiplying courts for the adminiftration of juftice, and by eftablifhing the long feries of appeals from jurifdiction to jurifdiction, in order that each cafe may be heard and re-heard, and receive an equitable fentence, the ftill more important advantages of prompt decifion are facrificed, and a door is opened for chicane.

It is univerfally acknowledged that the courts of exception are far too numerous; they enfeeble the authority of the eftablifhed judges, and withdraw a number of individuals from the fuperintendance of magiftrates who refide among them, and are readily acceffible, to confign them to the care of diftant and dilatory tribunals.

A confiderable degree of jealoufy and oppofition alfo fubfifts among many of the tribunals; hence they mutually weaken each other's authority, and the clients are configned over from court to court; fo that lawfuits become intolerably protracted, and a family is held in fufpenfe for two or three generations. The confequence of this is, that the rich wear out thofe of inferior fortune.

Even the ordinary and regular forms of civil procefs are flow and complicated. The hufbandman is called from his labour, the merchant from his commercial concerns, the artift from his work, and all from their domeftic affairs. Nearly an equal tardinefs takes place in criminal proceffes, fo that witneffes die, and means of proof are loft, while the guilty often efcape unpunifhed; and thofe who have been formally acquitted, are ftill fubject to a long detention in prifon, whence they are at length difmiffed without indemnity, and irretrievably ruined.

In confequence of the great number of courts, the facility of appeal from one to the other, and the tedioufnefs of law fuits; the multitude of judges, advocates, writers, and other fubordinate officers employed in the adminiftration of juftice is prodigious. The number of perfons employed in the different law eftablifhments has been eftimated at 100,000, which is nearly an hundredth part of the population of the country; and the very laft general enumeration of the inhabitants of Spain makes the number of advocates amount to 5675, and of writers to 9351; befides the judges and their fecretaries, the attorneys and their clerks, and the innumerable hoft of alguazils and inferior officers.

Another ferious inconvenience in the adminiftration of Spanifh law, is the neceffity of repofing entire and blind confidence in a clafs of fubaltern officers of the courts, called writers. This appears to be a branch of the profeffion wholly peculiar to Spain; the writer exercifing at the fame time the functions of fecretary, folicitor, notifier, regiftrar, and being the fole medium of communication between the client and the judge.

It is not cuftomary in Spain to allow either of the parties concerned any copy of the documents requifite for carrying on a fuit, except by the exprefs order of the judge. All the writings on both fides are collected together and bound up into a volume, which remains ftatedly in the poffeffion of the writer, who entrufts it for a certain time to the attorneys of the parties for the inftruction of advocates. The writer, to whofe care the documents of any fuit are committed, alfo regifters the decrees and fentences of the judges on the cafe, and notifies to the parties concerned, each ftep of the procefs, by reading to them the proper inftrument; without, however, allowing them to have a copy of it.

The union of fo many important functions in the fame perfon, neceffarily affords various opportunities for difhonefty; and the chance of being impofed upon is ftill further increafed by an unwife regulation which obliges the defendant, in any action, to choofe the fame writer as is employed by the plaintiff.

It may be remarked that fcarcely any other perfons are under equal temptations to difhonefty on account of the almoft total impunity that they enjoy in confequence of the following regulation. In all thofe diftricts where there are either a corregidor and fuperior alcade, or two fuperior alcades; each of thefe officers has an independent tribunal for the decifion of law fuits; and the right of pronouncing fentence in any particular cafe belongs to him of the two at whofe tribunal the firft application

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tion was made. Now the eftablifhed falaries of thefe officers are fo fmall, that the largeft part of their emoluments arifes from their fees: this portion of their income depends wholly on the writers, who have the power of inftituting fuits in which of the two courts they pleafe. The natural confequence is, that the judges are induced to overlook and pafs by in filence thofe malpractices of the writers which they cannot prevent without incurring a ferious perfonal lofs. Finally, the authority of the writers is irrefragably eftablifhed by the entire controul that they execute over all caufes. They alone receive the declarations and perfonal anfwers of the parties concerned; they alone receive the depofitions of the witneffes on each fide; put what queftions to them they pleafe; and record the anfwers without the interpofition, and even in the abfence, of the judges.

Another ferious defect in the adminiftration of juftice in Spain, is, that the party condemned, however clearly unjuft may have been his demand, or however weak may have been his defence, is fcarcely ever obliged to pay his adverfary's cofts of fuit; whence it perpetually happens, that the expences of gaining a juft caufe are much greater than the lofs of fubmitting to an unjuft demand; hence alfo it is in the power of a rich villain to oppres and ruin all thofe who are unable to fupport the expences of a law fuit; which in Spain are enormous, and perhaps the more fo, becaufe the eftablifhed charges are very light.

208 Religion.

The religion of Spain is the Roman Catholic; which, in this country and Portugal, has been carried to a pitch of fanaticifm unknown to the Italian ftates, or even in the papal territory. The inquifition, has in thefe unhappy kingdoms, been invefted with exorbitant power, and has produced the moft ruinous effects; having been formerly conducted with a fpirit totally the reverfe of the mildnefs and charity of Chriftianity. This evil has been recently fubdued in a confiderable degree; but one fanatic reign would fuffice to revive it. A yet greater evil, which has fprung from fanaticifm, is the deftruction of morals; for the monks being extremely numerous, and human paffions ever the fame, thofe afcetics atone for the want of marriage by the practice of adultery; and the hufbands, from dread of the inquifition, are conftrained to connive at this enormous abufe. The confcience is feared by the practice of abfolution, and the mind becomes reconciled to the ftrangeft of all phenomena, theoretic piety and practical vice united in bonds almoft indiffoluble.

According to the returns made to the government, the Spanifh clergy then ftood as follows.

Parochial clergy, called curas	16,689
Affiftants, called tenientes curas	5,771
Sacriftans or fextons	10,873
Acolitos to affift at the altar	5,503
Ordinados de patrimonio, having a patrimony of three rials per day	13,244
Ordinados de menores, with inferior ecclefiaftical orders	10,774
Beneficiados, or canons of cathedrals, and other beneficiaries	23,692
Monks	61,617
Carry forward	148,163
Brought over	148,163
Nuns	32,500
Beatas	1,130
Syndics to collect for the mendicants	4,127
Inquifitors	2,705
	188,625

The archbifhoprics were eight in number; and the bifhoprics 46. The moft opulent fee was that of Toledo, fuppofed to yield annually about 90,000l. The Mozarabic Miffal, compofed by St Ifidora for the Gothic church, after the converfion from Arianifm to the Catholic faith, continued to be ufed in Spain till the Moors were fubdued, when the Roman form was introduced.

209 Prefent ftate of the Spanifh clergy.

The Spanifh clergy, in proportion to the population of the country, is lefs numerous than was the clergy of France prior to the revolution; even their wealth is lefs confiderable, but better adminiftered; and their contribution to the public revenue is much greater. As to the general conduct of the Spanifh church, and its influence on the ftate, we may remark that after all the perverted and malicious induftry that has been exerted in the examination of this queftion, the refult has turned out highly favourable to the fuperior orders of the Spanifh clergy, who are, for the moft part, free from thofe irregularities which are charged on the clergy of other countries. The confpicuous fituations in the Spanifh church are by no means confidered as the patrimony of the rich and noble, but as the well-merited reward of irreproachable conduct. Whatever may be the rank of an ecclefiaftic in the facerdotal hierarchy, he never habitually abfents himfelf from his proper place of refidence, where he expends the revenue of his benefice in alms or public works. From the period of the reconqueft of Spain from the Moors, moft of the public eftablifhments owe their foundation to the clergy, by whom alfo whole towns have been rebuilt and raifed from their ruins. The moft beautiful aqueducts, fountains, and public walks in the cities, have been conftructed at the expence of their bifhops; from them alfo the poor have received the moft effectual relief in times of fcarcity, epidemic difeafe, and war. The bifhop of Orenfe converted his epifcopal palace into an almshoufe, where were lodged and fupported 300 French ecclefiaftics, condemned to tranfportation during the furies of the revolution; the prelate himfelf took his place at their table, and refufed to partake of any indulgence that he could not alfo procure for his guefts. Cardinal Orenzana, archbifhop of Toledo, converted the alcazar of that city into an eftablifhment wherein are received 200 children, and 700 poor perfons of all ages. The bifhop of Cordova, during the fcarcity of 1804, and for a long time afterwards, made a daily diftribution of 1200 rations of bread to the poor inhabitants of his diocefe. The aqueduct which conveys water to the city of Tarragona is the work of their archbifhop, who has thus conferred upon the place the inappreciable benefits of cleanlinefs and health; to both of which it was long a ftranger. Similar inftances of public merit may be found in almoft every diocefe.

With regard to the religious orders, their conduct is certainly lefs exemplary, though by no means meriting the reproaches that have been fo liberally caft upon them.

them. The reforms that have taken place at various periods have stopped the progress of the abuses introduced by length of time; and as the numbers of the monks have diminished, their pernicious influence on public opinion has proportionably declined. Some progress has been made in the desirable policy of uniting the different orders of the same rule into a single order; and from the present prohibition to receive novices, it is probable that several orders are about to be totally suppressed.

210 Language and literature.

The Spanish language is one of the great southern dialects which spring from the Roman; but many of the words become difficult to the French or Italian student, beause they are derived from the Arabic used by the Moors. The speech is grave, sonorous, and of exquisite melody, containing much of the flow and formal manner of the orientals.

The Spanish language is, in some respects, very rich; it abounds in compound words, in superlatives, derivatives, augmentatives, diminutives, and frequentative verbs; it has many quite synonymous words, and others which well express the different shades of meaning. In the technical terms of arts and sciences it is, however, extremely poor; a few of these it has borrowed from the Latin, and almost all the rest from the French.

On the whole, the Spanish is one of the finest of the European languages. It is dignified, harmonious, energetic, and expressive; and abounds in grand and sonorous expressions, which unite into measured periods, whose cadence is very agreeable to the ear. It is a language well adapted to poetry; but it also inclines to exaggeration, and its vehemence easily degenerates into bombast. Though naturally grave, it easily admits of pleasantry. In the mouth of well educated men it is noble and expressive; lively and pointed in that of the common people; sweet, seductive, and persuasive, when uttered by a female. Amongst the orators it is touching and imposing, though rather diffuse; at the bar and in the schools it is barbarous, and is spoken about the court in a concise and agreeable manner.

The literature of Spain is highly reputable, though little known to the other countries of Europe since the decline of Spanish power. The Bibliotheca Hispanica of Antonio will completely satisfy the curious reader on this subject. Among the fathers of literature in this country must be named Isidore of Seville, many of whose works are extant, and inferior in merit to few of that epoch. Lives of saints, and chronicles, are also found among the earliest productions; and successive writers may be traced to the 11th century, when they become numerous; but before mentioning some Spanish authorities posterior to that period, it will be proper to recollect that Arabian learning flourished under the caliphs of Cordova, and produced many illustrious names well known to the oriental scholar, as Aben Roe, or Averroes, Aben Zoar, Rhazes, &c. nor must it be forgotten that Aben Nazan wrote a book on the learning and authors of Spain. On this subject the inquisitive are referred to the work of Casiri.

In the 11th century, the Spanish authors began to increase in number, aud the native language begins to appear. This was the epoch of the famous *Cid*, Roderic Didac de Bivar, whose actions against the Moors were celebrated in contemporary songs, and by a long poem written in the following century. After the 13th century, it would be idle to attempt enumerating all the Spanish authors, among whom are Alphonso the Wise, who wrote the Libro del Teroso, a treatise on the Three Parts of Philosophy; and at whose command were compiled the famous Alphonsine Tables of Astronomy. Raymond Lully is said to have written not fewer than 319 books, full of metaphysical froth. In the 15th century appeared Juan de Mena, a poet of surprising powers, since which time a department of literature can scarcely be mentioned in which the Spaniards have not excelled. It would be unnecessary to repeat the well-known names of Cervantes, Quevedo, Lopez de Vega, and others, whose works are known to all Europe. The history of Mexico has been celebrated as a composition; but in fact it is defective and erroneous. The name of Bayer in learning, and of Feyjos in general knowledge, have recently attracted deserved respect; nor has the line of royal authors failed, an elegant translation of Sallust having been published by the heir apparent to the monarchy, the present Ferdinand VII *.

* Pinkerton's Geog. vol. i.

211 Education.

As the rudiments of education are in Spain generally imparted by the monks, it can scarcely be expected that useful knowledge should be common in that country. The accounts given on this subject by travellers, have thrown so little light on the state of education in Spain, that it can be generally understood only by comparison with other Catholic countries. In this comparison Spain will be found inferior to France and Italy, but in many respects superior to Austria and the German states.

212 Universities.

The number of universities in Spain was formerly 24, but only the following 17 now remain, viz. that of Pampeluna, in Navarre; of Oviedo, in the Asturias; of San Jago, in Galicia; of Seville, and of Granada, in the provinces of the same name; of Huesca and Zaragoza, in Aragon; of Avila, Osma, and Valladolid, in Old Castile; of Toledo, Siguenza, and Alcala de Hamarez, in New Castile; of Cervera, in Catalonia; of Orihuela and Valencia, in Valencia; and of Salamanca, in the province of Leon. Of these the most celebrated, are the universities of Zaragoza, Toledo, Alcala, Cervera, and Salamanca.

The university of Zaragoza has 22 professors, and that of Toledo has 24; about 900 students attend the classes of the former, and nearly 3000 those of the latter; yet neither of these establishments is known in Europe, or regarded as of high reputation even in Spain.

The university of Alcala, established at a prodigious expence by Cardinal Ximenes, answered for nearly a century the views of its illustrious founder. This splendid institution consists of 31 general professors, and 13 colleges, each of which has its particular establishment of masters and professors, and of students, who receive gratuitous support and instruction. At present, however, this university is gone so entirely to decay, that scarcely a vestige of its ancient splendour remains, and the whole number of students scarcely amounts to 500.

The university of Cervera, founded at the commencement of the 18th century, with a magnificence truly royal, possesses 43 professors, five colleges, about 900 students; but it partakes of the radical fault of all the Spanish universities; the course of study is incomplete and antiquated, and the very name of the institution is scarcely known beyond the boundaries of Catalonia.

Spain.

The univerfity of Salamanca, the moft ancient of any in Spain, has enjoyed a degree of celebrity which entitles it to a particular defcription.

It was founded by Alphonfo IX. between the years 1230 and 1244, and was confiderably enlarged by Ferdinand III. his grandfon. But its moft magnificent patron was Alphonfo X. furnamed the Wife, fon and fucceffor of the laft mentioned fovereign. This prince richly endowed it, and drew up a fet of ftatutes for its government. He eftablifhed a profefforfhip of civil law, with a falary of 500 maravedies; a profefforfhip of canon law, with a falary of 300 maravedies; two profefforfhips of decretals with falaries of 500 maravedies; two profeffors of natural philofophy, and as many of logic, with falaries of 200 maravedies each; and two mafters of grammar, with falaries of 300 maravedies. It experienced alfo the liberality of many fucceeding fovereigns, and received from the popes a vaft extent of privileges.

For many years this univerfity enjoyed a high reputation; its fame extended over all Europe; it was confulted by kings and by popes, and its deputies were received into the general councils, where they well fuftained the character of the body which they reprefented. Students flocked to it not only from all the provinces of Spain and Portugal, and from the iflands of Majorca and the Canaries, but alfo from the Weft Indies and New Spain, and even from France, Flanders, and England. The number of ftudents who attended the claffes amounted nearly to 15,000. The whole of this vaft eftablifhment confifted of 25 colleges, a library, and an hofpital, called *Del Eftudio*, intended for the amelioration of poor fcholars.

The celebrity of Salamanca continued in full vigour during many ages; but, at length, as rival inftitutions fprang up, declined by flow degrees, fo that by the year 1595, the number of ftudents did not exceed 7000*.

* Dr ... 213

State of the Spanish stage.

After the evacuation of Spain by the Romans, theatrical reprefentations were difcontinued till they were reftored by the Moors, and from them adopted by the Gothic Spaniards, who foon became paffionately fond of the ftage, a tafte which they have ever fince preferved.

They had at firft neither theatres nor a ftage, their dramas were acted in a court, a garden, or the open fields; the actors and fpectators were mingled, and were equally expofed to the injuries of the weather.

At a fubfequent period the ftage was marked out by a kind of boarded platform, and was furrounded by old clothes, drawn back, on occafion, by means of cords, which formed the only decorations, and behind which the actors dreffed. Their properties confifted only of crooks, fome wigs and falfe beards, and a few white fkins, trimmed with gold fringe.

Theatrical exhibitions became more regular and decent towards the end of the 16th century, when a new form was given to them by the exertions of Bartholemew Naharro, a middling dramatic poet. Theatres were then erected, but the greateft part were upon treffels, and two parallel pieces of canvas formed their fcenes, which were fometimes checquered with various colours, fometimes covered with miferable paintings, or adorned with foliage, trees or flowers.

During all thefe periods, the prompter, with a candle in his hand, ftationed himfelf on the ftage by the fide of the performers who were fpeaking, and jumped from fide to fide whenever the actors changed their places. This cuftom prevailed at the end of the 17th century, and even ftill prevails among the ftrolling companies of fmall towns.

Theatres have at length, however, affumed a handfomer appearance in this country, and cuftoms more conformable to the reft of Europe. Handfome theatres have been multiplied, and their ftages are now well arranged and decorated; all the great cities are well provided with them, and many of the fmaller towns may boaft of elegant and not ill furnifhed playhoufes.

The prompter no longer runs from one fide of the ftage to the other; he is placed in the middle before the fcenes, in a kind of well, where he no longer offends the fight and tafte of the fpectator: but an old cuftom which is ftill obferved, greatly injures the intereft and effect of the reprefentation. The prompter, who has the piece before him, does not wait till the actor is at a lofs to prompt him, but recites the whole drama aloud, fo that the actor appears to follow him in his declamation. By this means two voices are heard in the theatre pronouncing the fame words, which are confounded, and often produce a difcord, and the fpectator who has firft heard the piece recited, no longer takes an equal intereft in the fame verfes, phrafes, and words, which the actor afterwards declaims.

The Spanifh theatres are divided into a *patio*, or area, and boxes called *balco* and *apofentos*. The orcheftra, where the muficians are ftationed, adjoins the ftage; an inclofure between it and the pit is fet round with arm chairs, and deftined for the reception of the higher clafs: the *patio*, or pit, is placed behind, and filled with benches, and the *gradas* confift of two rows of benches difpofed amphitheatrically on each fide below the boxes, and fometimes alfo acrofs the lower end of the theatre. This laft divifion is found only in a few theatres; in the others, the fpace beneath the boxes is empty, and perfons ftand in it. The *patio* and the *gradas* contain the common people, the moft numerous, moft noify, and moft imperious part of the public.

There are commonly only two tiers of boxes, fometimes three; they extend on each fide from the ftage to the end of the theatre. The form is the ufual one, but they are divided from each other by partitions, which completely fhut them up on each fide, a circumftance which greatly injures the beauty of the general effect.

There is commonly at the end of the theatre fronting the ftage, a large box with feats placed femicircularly behind one another, which is called the *cazuela*. No man is allowed to enter it, and only women muffled up in their *mantelas* are admitted.

There are feveral things very fingular and amufing in this cazuela. Women of every age and condition are there united; the married are confounded with the fingle; the wives of the common people with thofe of tradefmen and the ladies of the court; the poor woman with the rich one who would not be at the trouble of dreffing to appear in her box. Their appearance is moft curious; they are all covered with their *mantelas*, a kind of white or black veil, and give the idea of a choir of nuns. It is the place for chattering, and between the acts there proceeds from the cazuela a confufed noife like the hum of bees, which aftonifhes and diverts all who hear it for the firft time. Scarcely is the performance ended, when the door of this box, its galleries, paffages, and the ftaircafe leading to it, are

Spain. all besieged by a great crowd of men of every condition; some attracted by curiosity; others coming to wait upon the women who are in it.

Notwithstanding all that has been done for its improvement, the Spanish stage is still far from the celebrity which it once possessed; and the people do not second the efforts of their best writers. The acting is in a still lower state. The performers possess neither that dignity which characterizes great personages, and ennobles a subject without injuring its interest; nor that sweet expression of voice and gesture which goes to the heart, and awakens the sentiments it expresses. In their acting every thing is violent or inanimate; every thing departs from nature. Their recitation is a feat of strength, and is performed at the sole expence of the lungs. Cries and shrieks are its most impressive part, and the most applauded by the majority of the audience. They put nothing in its proper place: all their action is exaggerated; when they threaten they roar; when they command they thunder; when they sigh, it is with an effort which completely exhausts the breath. They substitute anger for dignity, violence for spirit, insipidity for gallantry. Their gestures rarely correspond with the sentiments they ought to express; but resemble their recitation; and are usually monotonous, capricious, ignoble, and almost always violent. The women, in their bursts of passion, become furies; warriors become villains; generals robbers; and heroes bravos. Nothing, as they manage it, is pathetic; nothing makes any impression on the audience. The spectators, equally unmoved at the end of the piece, as at the beginning, see it, without having experienced a single moment of interest or emotion *.

* De Laborde.

214 Produce and agriculture.

As labour and culture are reckoned derogatory to the Spanish character, a sufficient quantity of grain for the support of the inhabitants is not raised, though societies for the encouragement of agriculture have been established in different parts of the kingdom. The principal products are wine, delicious fruits, oil, silk, honey, and wax. A considerable proportion of the mountains and valleys is pastured by immense flocks of sheep, whose wool is extremely fine and valuable. Estremadura is noted for its excellent pastures; and the wool in Old Castile is reputed the finest in the kingdom. In Catalonia the hills are covered with forest and fruit trees. Valencia is celebrated for its silk, and for the exquisite flavour of its melons. Murcia abounds in mulberry trees; and the southern provinces yield the most delicious wines and fruits. Upon the whole, it has been observed of Spain, that few countries owe more to nature, and less to industry.

The soil in general reposes on beds of gypsum, which is an excellent manure. The common course of husbandry about Barcelona begins with wheat; which being ripe in June, is immediately succeeded by Indian corn, hemp, millet, cabbage, kidney beans, or lettuce. The second year these same crops succeed each other as before. The next year they take barley, beans, or vetches; which coming off the ground before midsummer, are followed, as in the former years, by other crops, only changing them according to the season, so as to have on the same spot the greatest possible variety. Near Carthagena the course is wheat, barley, and fallow. For wheat they plough thrice, and sow from the middle of November to the beginning of December; in July they reap from 10 to 100 for one, as the season happens to be humid. The rich vale of Alicant yields a perpetual succession of crops. Barley is sown in September, reaped in April; succeeded by maize, reaped in September; and by a mixed crop of esculents which follow. Wheat is sown in November, and reaped in June; flax in September, pulled in May. In the vale of Valencia wheat yields from 20 to 40; barley from 18 to 24; oats from 20 to 30; maize 100; rice 40. The Spanish plough is generally light; and is drawn by oxen with the yoke over the horns; the most proper and natural mode, as the chief strength of the animal centres in the head. For a very minute account of agriculture in Spain, see De Laborde's View, vol iv. chap. 2.

215 State of the arts.

That prejudice which regards the mechanic arts as base, is not yet extinguished in Spain; hence it happens that these arts are either neglected, or abandoned to such unskilful hands as in general to render the Spaniards much behind their neighbours, in the useful arts of life. The influence of this prejudice is least in the province of Catalonia, where the laws, customs, and opinions are favourable to artizans; and it is accordingly in this province that the mechanic arts have made the greatest progress. Foreign artists experience great difficulties in this country. They are not allowed to practice without gaining admission into some incorporation or company, and this has almost always been refused them.

Some arts have, however, made considerable progress in Spain, especially those of gilding leather, and printing, which has lately acquired a great degree of perfection.

The fabrication of articles of gold and silver might become an important object in a country where these metals abound; but it is neglected, and the demand is almost entirely supplied from foreign markets. What little they perform in this way at home is usually very ill executed, and exorbitantly dear. Madrid, however, begins to possess some good workmen in this way; encouragement would increase their number, and facilitate the means of improvement; but manual labour is there excessively dear. Hence the Spaniards prefer foreign articles of this kind, which, notwithstanding the expence of carriage, the enormous duties which are paid on these articles, and the profits of the merchants, are still cheaper than those made at home.

216 Architecture.

The liberal arts are cultivated in this country with more assiduity and success. The 16th century was the most brilliant period of the arts in Spain, as well as of the sciences, of literature, and of the power and grandeur of the monarchy. A crowd of able architects appeared at once under Charles V. and Philip II. They erected numerous edifices, which will immortalize the reigns of these princes and the names of the artists. John de Herrera and Cepedes displayed the highest talents; Pedro de Uria constructed the magnificent bridge of Almaraz, in Estremadura; John-Baptist-Monegro of Toledo, assisted in the building of the Escurial, and of the church of St Peter at Rome.

The structures of that age are the finest in Spain, and perhaps the only ones in the country which deserve to fix the attention of the skilful spectator. There are some among them which, in regularity, solidity, and magnificence, deserve to be compared with the fine buildings of the Romans. The bridges of Badajoz over the Guadiana, and of Toledo, over the Manzanares, are of this period; as are also the grand house or palace, now the council-

Spain. council-houſe at Madrid, and the beautiful edifices which adorn Toledo; the palace of Los Vargas; the hoſpital of St John the Baptiſt, and that of the Holy Croſs. During the ſame time, the *alcazar* of this city, built under Alphonſo X. was reſtored with the grandeur and magnificence which it ſtill diſplays; and the noble palace was erected, known under the name of the Houſe of Pilate, at Madrid.

That magnificent building the Eſcurial, which the Spaniards called the eighth wonder of the world, which uſed to lodge at once the king and his court, and 200 monks; this famous palace, which aſtoniſhes us by its maſs and extent, by the ſtrength of its ſtructure, the regularity of its proportions, and the ſplendour of its decorations, as much as by the repulſive appearance of its ſite and neighbourhood, alſo belongs to the ſame period, having been erected in the reign of Philip II.

The decline of architecture became as complete in the 17th century as its ſtate had been flouriſhing in the preceding age. From this period no architect occurs worthy of remembrance; and the buildings are monſtrous maſſes, deſtitute of order, taſte, and regularity. One only deſerves notice, the priſon of Madrid, called Carcel de Conte, the work of a happy genius, who knew how to profit by the bright examples of the preceding period.

About the middle of the 18th century, however, architecture began again to be cultivated with ſucceſs. The academy of San-Fernando, at Madrid, has already produced ſeveral able men in this branch, who purſue their art with credit. The handſome bridge built over the Xarama, between Aranjuez and Madrid, in the reign of Charles III. diſplays the talents of Mark de Vierna, his architect; the cuſtom-houſe of Valencia, and the temple-church of the ſame city, conſtructed on the plan of Michael Fernandez; the exchange of Barcelona; the triumphal arch which forms the gate of Alcala, at Madrid, and the ſnuff manufactory at Seville, do honour to the Spaniſh architecture of the preſent day.

217 Painting. Spain juſtly boaſts of many eminent ſculptors; but of all the liberal arts, painting is that which has been moſt cultivated in Spain, and in which its natives have beſt ſucceeded. The Spaniſh ſchool is much leſs known than it deſerves: it holds a middle place between the Italian and Flemiſh ſchools; it is more natural than the former, more noble than the latter, and partakes of the beauties of both. It has particularly excelled in ſacred ſubjects; and we recogniſe in the Spaniſh pictures the feelings uſually experienced by the people of the myſteries of religion. By none have devout ecſtaſy, fervour, and genuine piety, been ſo well expreſſed, or the myſtic paſſion given with ſo much truth. It is not in correctneſs of deſign, or nobleneſs of form, that the Spaniſh artiſts uſually excel, but in the pure imitation of nature, in grace, truth, effect, and the expreſſion of feelings.

The Spaniards have at length opened their eyes to the utility of the arts; they acknowledge them to be advantageous and deſerving of reſpect, and have begun to give them ſuch encouragement as is likely to promote a taſte for them, and to inſure their advancement. Government has done ſomething by affording protection and countenance to the new eſtabliſhments; but the ſtrongeſt impulſe has been given by individuals, or private aſſociations.

Spain now poſſeſſes an academy of painting, at Seville, and two academies of the fine arts, one at Madrid, and the other at Valencia. The firſt owes its origin to an aſſociation of the painters of Seville formed by themſelves, about the year 1660; Charles III. revived it, and eſtabliſhed there a ſchool of the fine arts. That of Madrid was founded by Philip V. The laſt was eſtabliſhed by the exertions of ſome private perſons, aſſiſted by the benefaction of Andrew Majoral, archbiſhop of Valencia, and the protection of the municipal body. Charles III. came to its aſſiſtance 26 years after its eſtabliſhment, with an annual gift of nearly 700l. Theſe academies have for their object the ſtudy and improvement of painting, ſculpture, and architecture; they give public leſſons on theſe three arts, and diſtribute annual prizes among their pupils. That of Madrid, or San-Fernando, ſends its pupils to Rome at the expence of government, to complete their ſtudies.

Public and gratuitous ſchools for drawing have been eſtabliſhed within the laſt 20 years in different places; at Madrid, Cordova, Valencia, Seville, Zaragoza, Barcelona, &c. The laſt of theſe is ſupported by the merchants; that of Vergara was founded by the patriotic ſociety of Biſcay; and thoſe of Zaragoza and Cordova owe their birth to the zeal and generoſity of two individuals; the firſt to Don Martin Noy Cochear, the laſt to Don Antonio Cavallero, the preſent biſhop of Cordova. Thoſe of Madrid, Seville, and Valencia, depend on the academies of theſe cities.

218 Manufactures. The manufactures of Spain were more flouriſhing during the government of the Moors in that country, than they have been at any ſubſequent period. So completely had the kingdom declined in this reſpect at the end of the 16th century, when Philip V. aſcended the throne, that it is ſaid by De Laborde to have been abſolutely deſtitute of trade. The inteſtine wars which ravaged the kingdom during the firſt 14 years of that reign, and the low ſtate to which the national finances were reduced, prevented the government from paying attention to manufactures; and it was not till after tranquillity had been reſtored, and regulations adopted with reſpect to the public revenue, that the natives were induced to wear articles of their own manufacture. Since the reigns of Ferdinand VI. and Charles III. this part of the internal trade of the kingdom has greatly improved, and the manufactures of Spain are now once more on a reſpectable footing.

The Spaniſh manufactures enumerated by De Laborde, in his View of Spain, are thoſe of cloth and other woollen goods; ſilks; brocaded ſtuffs in gold and ſilver; linens and other articles formed from flax or hemp; cottons; leather, and other articles manufactured from ſkins and hides; paper; china and delft ware; brandies; beer; aquafortis; ſalt of lead; ſhears for the woollen trade; copper, iron, and braſs goods; glaſs and mirrors; ſoap; hats; articles for the marine; military implements; arms and ammunition; tobacco and ſnuff. Of theſe, the moſt important are, the woollen and ſilk manufactures; leather; brandy; military weapons; ſoap and tobacco.

The principal places for the woollen manufactures are, Aulot, Arens, Vich, and the convent of Gironne in Catalonia; Jaca, and the diſtrict of Cincavilla in Aragon, and Burgos in Old Caſtile, for woollen ſtockings; Barcelona, Zaragoza, and Burgos, for blankets; Junquera, Segovia, Burgos, and many others for baizes and

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and flannels; Estella in Navarre, Escoray in Biscay, Grazolerna in Seville, Toledo, &c. for coarse cloths, which last article is manufactured in large quantities throughout the kingdom. The woollen stuffs fabricated in Spain are in general of a very inferior quality, the wool being imperfectly scoured, and the dyeing so ill executed that the colours are never permanent.

The chief manufactures for silken articles are those for blonde lace throughout Catalonia, and at Almagro in La Mancha; for silk stockings, at Malaga, Zaragoza, Valencia, Talavera, and Barcelona; and for silk taffeties, serges, damasks, and velvets, at Jaen, Granada, Murcia, Valencia, Malaga, Zaragoza, Toledo, Talavera, and Barcelona. The articles of this manufacture are in general stout and excellent; but they do not possess that brilliancy of appearance so remarkable in the French silks.

Tanning, currying, and dressing hides, skins, and all kinds of leather, are very general throughout Spain; but the skins and hides prepared at Arevaca and Pozuelo, are in greatest repute. The greatest quantity of sole leather is manufactured in the provinces of Aragon and Catalonia; and in the latter province are made and exported a prodigious number of shoes.

The making of brandy is confined chiefly to the states belonging to the crown of Aragon, especially at Torres in Aragon; at Selva, Mataro, &c. in Catalonia; and in Valencia.

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Spain has long been famous for its manufacture of military weapons; and it is well known that the swords, sabres, hangers, and bayonets, made at Toledo and Barcelona, are of a very superior temper. Large manufactories for fire-arms occur in the district of Guipuscoa, and two royal founderies for brass cannon, are established at Barcelona and Seville.

There is only one manufactory for tobacco and snuff in Spain, viz. at Seville; but this is on a most extensive scale, and is supposed to yield of annual profits about 800,000l. sterling. Here are employed 202 mills, turned by 300 horses or mules; and the various operations call for the daily labour of above 1400 persons. 219

Commerce.

Considering the extent of sea coast belonging to the kingdom of Spain, its commerce is but inconsiderable, and principally takes place between the mother-country and the American colonies. Spain, indeed, carries on a foreign trade with every country in Europe; but its principal transactions are, with England, Holland, Italy, and France. Its exports to these countries consist almost entirely of raw produce, as, if we except oil, wine, brandy, shoes, salt, and a few coarse cloths and silken articles, the trade in manufactured goods is almost wholly confined to the interior of the country. Its chief exports, and the amount yielded by each for the several provinces, as well as the whole amount of the export trade of Spain, to the rest of Europe, will be seen in the following table.

Value of Exports from each Province in pounds sterling.

Goods exported.	*Catalonia.*	*Valencia.*	*Andalusia.*	*Murcia.*	*Aragon.*	*Other Provinces.*	*Total.*
Nuts,	L. 26,000	L.	L.	L.	L.	L.8,336	L.34,336
Oil,	26,667	-	208,333	-	-	-	235,000
Cork,	235,990	-	-	-	-	-	235,990
Wine,	2,667	103,333	508,333	31,250	-	-	645,583
Linens and cotton stuffs,	295,007	-	-	-	-	-	295,007
Silk handkerchiefs,	51,042	-	-	-	-	-	51,042
Paper,	73,333	-	-	-	-	-	73,333
Brandy,	262,500	125,000	-	-	-	-	387,500
Shoes and shoe soles,	22,024	-	-	-	-	-	22,024
Raisins,	-	10,625	625,000	-	-	-	635,625
Dried figs,	-	5,333	34,375	-	-	-	39,708
Almonds,	-	6,563	-	-	-	-	6,563
Dates,	-	6,250	-	-	-	-	6,250
Barylla,	-	15,875	-	108,333	-	-	124,208
Kermes,	-	7,292	-	-	-	-	7,292
Salt,	-	9,250	833,333	-	-	-	842,583
Spart worked,	-	-	-	4,166	-	-	4,166
Silk,	-	-	-	229,166	38,333	-	267,499
Cutlery,	-	-	-	5,000	-	-	5,000
Ribbons,	-	-	-	2,083	-	-	2,083
Corn,	-	-	-	78,041	53,437	-	131,478
Saffron,	-	-	-	2,500	-	-	2,500
Wool,	-	-	-	-	48,750	641,682	690,432
Flax,	-	-	-	-	1,458	-	1,458
Coarse cloths,	-	-	-	-	2,666	-	2,666
Silk and wool mixtures,	-	-	-	-	5,833	-	5,833
Worsted stockings,	-	-	-	-	540	-	540
Salt provisions,	-	-	-	-	-	A large quantity	
Oranges and lemons,	-	-	-	-	-	from Gallicia.	
Hemp,	-	-	-	-	79,063		79,063
Madder,	-	-	-	-	-	From Old Castile	66,667
Brooms,	6,875	-	-	-	-	-	6,875
	1,002,105	[illegible]89,521	2,209,374	460,539	230,080	716,685	4,908,304

The

Spain. The above table is confined almoft entirely to the European exports. To thefe muft be added the amount of Spanifh exports to the American colonies in order to acquire a juft view of the total amount of the export commerce. The following table will fhow the amount of the exports, both of home and foreign produce, from Spain to America in 1784, as eftimated by Mr Townfend in pounds fterling.

Ports.	Home produce.	Foreign produce.	Total.
Cadiz	1,438,9 2	2,182,531	3.621,443
Malaga	196,379	14,301	210,680
Seville	62,713	30,543	93,256
Barcelona	122,631	21,240	143,871
Corunna	64,575	39 962	104,537
Santander	36,715	90,173	126,888
Canaries	24,974		24,974
Tortofa	7,669	289	7,958
Gijon	4,281	10,190	14471
Total	L.1,958,849	L.2,3[illegible]9 229	L.4.384,878

Of thefe exports we are to regard chiefly thofe of Spanifh produce, and thefe Mr Townfend has probably eftimated too high. M. de Laborde, on whofe authority we are more difpofed to rely, ftates the value of Spanifh domeftic merchandife exported to America in the year 1788, as amounting to 1,635,658l. fterling, while in 1792, it amounted to 2,812,500l; fterling, and on an average of five years, from 1788 to 1792, it amounted to 1,833,333l. fterling. The amount of foreign merchandife exported in 1788, was 1,484,315l. fterling. Adding the average to this laft fum, we have 3,317,648l. fterling for the whole export trade to America. This added to 4,908,304l. fterling, makes a grand total of 8,225,952l. fterling for the whole export trade of Spain.

The Spanifh imports are much more confiderable than the exports. Before the prefent troubles, Spain imported from Holland, tapes, linen drapery, common lace, cutlery goods and paper; from Silefia linen drapery; from Germany, more particularly from Hamburgh, quantities of haberdafhery; from England, calicoes, iron and fteel goods, fine cloth, quantities of cod fifh and ling; the value of the laft articles is eftimated at three millions of duros, five millions livres tournois, (208,333l. 13s. 4d.); from France, calicoes, linen drapery, filk ftockings, filks, camlets, and other kinds of worfted ftuffs, fine cloths, gilded articles, jewellery, iron goods, haberdafhery, fteel goods, and perfumery.

We have not fatisfactory documents fufficient to afcertain the amount of thefe imports, but it was certainly much lefs than that of the imports from the American colonies. Thefe latter, according to Mr Townfend's ftatement, amounted in 1784 to 12,635,173l. fterling; to which, if we add nearly half a million for duty, we fhall have a total of above thirteen millions fterling for American imports alone. De Laborde eftimates the total amount of American imports for the year 1788 at 8,382,330l. fterling, of which Cadiz alone imported 6,6[illegible]7,873l. fterling. If to the above amount we add 577,679l. for the duty at the fame period, we fhall have a total of 8,960,009l. fterling againft the mother country, deducting from this 3,317,648l. for the average exports, we have 5,642,361l. as the balance of trade in favour of the Spanifh colonies. Spain.

220 Inland navigation. Though there are in Spain many navigable rivers, few canals of communication have been conftructed to improve the internal navigation of the country. The canal of Aragon, completed during the reign of Charles IV. muft be highly beneficial to that province. Two canals, viz. that of Tueuftre and the imperial canal, both of which begin at Navarre, run in various windings through Aragon, by turns receding from or approaching the river Ebro, where at length they terminate. Befides the dykes, banks, fluices, and bridges neceffary in the courfe of thefe canals, an aqueduct has been conftructed in the valley of Riozalen, 710 fathoms in length, and 17 feet thick at the bafe, in which the canal runs.

The canal of Caftile, projected and begun in the laft reign, has been almoft abandoned. It was to commence at Segovia, fixteen leagues north of Madrid, to follow the courfe of the Erefma, that falls into the Douro, and to be continued as far north as Reynofa; which is twenty leagues from St Ander, a fea port. At Reynofa is the communication with the canal of Aragon, that unites the Mediterranean to the bay of Bifcay. Above Palencia, a branch goes weftward through Rio-Seco and Benevento to Zamora; making the canal of Caftile, in its whole extent 140 leagues; where it is completed, viz. between Reynofa and Rio-Seco, its width at top is 56 feet, at bottom 20, and nine in depth.

In 1784, a canal was planned, which, from the foot of the mountains of Guadarama near the Efcurial, fhould proceed fouthward to the Tagus; afterwards to the Guadiana, and terminate at the Guadalquivir above Andaxar. Some other attempts to improve the inland navigation of the country have been unfuccefsful.

221 General character of the Spaniards. There is no nation in Europe which difplays fuch a variety of national character as Spain. In no two provinces are the manners and character exactly alike. It is therefore difficult to collect traits on which to found the national character of the Spaniards; and this character has been varioufly reprefented by different writers. From the tranfactions which have lately taken place between that people and the Britifh nation, we confefs ourfelves prejudiced againft them; and we fhall therefore, inftead of fketching their character according to our own preconceived notions, endeavour to delineate it as concifely as poffible from De Laborde, who is probably a fufficiently competent judge.

The national pride, fays this author, is every where the fame. The Spaniard has the higheft opinion of his nation and himfelf, and this he expreffes with energy, in his geftures, words, and actions. This opinion is difcovered among all ranks in life, and all claffes of fociety. Its refult is a kind of haughtinefs, fometimes repulfive to him who is its object, but ufeful in giving to the mind a fentiment of noblenefs and felf-efteem which fortifies it againft all meannefs.

In later times the Spaniards have not degenerated from the valour of their anceftors. The Spanifh foldier is ftill one of the beft in Europe, when placed under an experienced general, and brave and intelligent officers. He poffeffes a cool and fteady valour; he long endures fatigue and hunger, and eafily inures himfelf to labour.

The Spaniards are very referved, and rather wait for, than

than court the advances of a ſtranger. Yet in ſpite of their apparent gravity, they poſſeſs an inward gaiety, which frequently ſhines out when proper occaſions call it forth.

The Spaniard is very ſlow in all his operations; he often deliberates when he ought to act, and ſpoils affairs as much by temporiſing as the natives of other countries do by precipitation. This tardineſs would be but a ſlight defect, did it not proceed from a ſerious radical want, from the invincible indolence and hatred of labour which prevails among all ranks of ſociety.

That jealouſy which was formerly proverbial among the Spaniards, is now greatly diminiſhed; huſbands are much leſs ſuſpicious, and women much more acceſſible. Lattices have diſappeared; duennas exiſt only in romances; veils are exchanged for mantelas; houſes are thrown open, and the women have recovered a liberty by which they are leſs tempted to go aſtray than when their virtue was entruſted to locks and grates, and to the ſuperintendance of guards often faithleſs and eaſily corrupted.

In fine, the Spaniards are ſober, diſcreet, adroit, frank, patient in adverſity, ſlow in deciſion, but wiſe in deliberation; ardent in enterpriſe, and conſtant in purſuit. They are attached to their religion, faithful to their king, hoſpitable, charitable, noble in their dealings, generous, liberal, magnificent; good friends, and full of honour. They are grave in carriage, ſerious in diſcourſe, gentle and agreeable in converſation, and enemies to falſehood and evil ſpeaking.

222 Diverſities of character in the ſeveral provinces.

Such is the Spaniſh character as drawn by De Laborde. Its varieties in the ſeveral provinces are thus ſtated by the ſame author. The Old Caſtilians are ſilent, gloomy, and indolent, and are the moſt ſeverely grave of all the Spaniards; but they poſſeſs a ſteady prudence, an admirable conſtancy under adverſity, an elevation of ſoul, and an unalterable probity and uprightneſs. The character of the natives of New Caſtile is nearly the ſame, but more open, and leſs grave and taciturn. Indocility and conceit make part of the character of the people of Navarre: they are diſtinguiſhed by lightneſs and adroitneſs. The Biſcayans are proud, impetuous, and irritable; abrupt in diſcourſe and in action; haughty and independent, but induſtrious, diligent, faithful, hoſpitable, and ſociable. The Gallicians are gloomy, and live very little in ſociety; but they are bold, courageous, laborious, very ſober, and diſtinguiſhed for their fidelity. The Aſturians partake of the character of the Gallicians and Biſcayans; but they are leſs induſtrious than the former, leſs civilized, leſs ſociable, leſs amiable, and more haughty than the latter. The people of Eſtremadura are proud, haughty, vain, ſerious, indolent; but remarkably ſober, honourable, and much attached to their own province, which they ſeldom quit. The Murcians are lazy, liſtleſs, plotting, and ſuſpicious; attached neither to ſciences, arts, commerce, navigation, nor a military life. The Valencians are light, inconſtant, and indeciſive; gay, fond of pleaſure, little attached to each other, and ſtill leſs to ſtrangers, but affable, agreeable, and diligent. The Catalans are proud, haughty, violent in their paſſions, rude in diſcourſe and in action, turbulent, untractable, and paſſionately fond of independence; they are not particularly liberal, but active, induſtrious, and indefatigable; they are ſailors, huſbandmen, and builders, and reſort to all corners of the world to ſeek their fortunes. They are brave, intrepid, ſometimes raſh, obſtinate in adhering to their ſchemes, and often ſucceſsful in vanquiſhing, by their ſteady perſeverance, obſtacles which would appear inſurmountable to others.

223 Manners and cuſtoms.

The natives of almoſt every province have ſome diſtinguiſhing peculiarity in their dreſs, manners, and purſuits. Before the acceſſion of the houſe of Bourbon to the throne, the uſual dreſs of a Spaniſh nobleman conſiſted of a ſlouched hat, a long black or brown cloak, ſhort jerkin, and ſtrait breeches, with a long Toledo ſword; but French dreſſes are now introduced at court. The higher claſſes wear their hats under their arm. The common people wrap themſelves up to the eyes in a brown cloak, called *aleopo*, that reaches to the ground; and conceal their hair beneath a cotton cap, and a broad hat called a *ſombrero*. When a lady walks abroad, her head and upper part of her body are covered with a mantela; that is, a white or black veil, ſo that it is impoſſible ſhe ſhould be known. At home, the dreſs is a jacket and a petticoat of ſilk or cotton. The hair is generally a fine black; and powder is rare.

In romance, the ladies are celebrated for beauty, and ſome of them deſerve that character; yet beauty is not their general character. They are of a ſlender make, but with great art they ſupply the defects of nature. By an indiſcriminate uſe of paint, they diſfigure their complexion and ſhrivel their ſkin.

Several of the Spaniſh cuſtoms and habits, which ſeem ridiculous to foreigners, are gradually wearing out, and in proceſs of time will no doubt be corrected. The higher claſſes at breakfaſt uſe chocolate, and ſeldom tea. Dinner generally conſiſts of beef, veal, pork, mutton, and beans, boiled together. They are fond of garlic; and it is proverbial that olives, ſalad, and radiſhes, are food for gentlemen. The men drink little wine, and the women uſe water or chocolate. Both ſexes ſleep after dinner, and air themſelves in the cool of the evening. Their repaſts are compoſed of ſweatmeats, biſcuit, coffee and fruit, which ſervants diſtribute to the company; who keep their ſeats, and have little converſation.

Dancing and cards are favourite amuſements. Theatrical exhibitions are generally inſipid or ridiculous bombaſt, low wit, abſurdity, and buffoonery. The combats of the cavalleros and bull fights, are almoſt peculiar to this country. On theſe occaſions young gentlemen were uſed to ſhow their courage to their miſtreſſes; and were honoured and rewarded according to their ſucceſs. But theſe exhibitions were lately conducted with greater economy and parſimony; and mercenary champions ſtudied in the moſt ſecure and graceful manner to deſtroy the devoted animal. See *BULL-Fighting*.

The chief defect in all ranks is an averſion to labour and induſtry. The higher orders beſtow no attention on agriculture and commerce; they reſide for the moſt part at court and in the metropolis, reckoning it beneath their dignity to live in villas on their eſtates among their tenants. In their eſtimation, a labouring man quits the dignity of the Spaniſh character, and renders himſelf an object of contempt. Hence a liſtleſs indolence prevails. Thouſands waſte their time in total want of every incitement to action. Their intellectual powers lie dormant, and their views and exertions are confined within the narrow ſphere of mere exiſtence. The common people have no encouragement to induſtry; and muſt feel little

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concern for the welfare of a country where a few overgrown families engrofs every thing valuable, and never think of the condition of their vaffals. The indigent Spaniard does not beftir himfelf unlefs impelled by want, becaufe he perceives no advantage to be derived from induftry. A ftranger to intemperance and excefs, his fcanty fare is eafily procured; and under a climate fo propitious, few clothes are required. The hovel which he occupies, together with all its contents, has a mean, filthy, defpicable appearance; and all that relates to him bears the impreffion of wretchednefs and mifery *.

* Playfair's Geography, vol. i. p. 68.

There are certain cuftoms which may be regarded as peculiar to the Spaniards, or which at leaft are fcarcely found in any other European country. The number of fervants retained in the families of the higher ranks is prodigious; and even a tradefman's wife, in narrow circumftances, will frequently have four maid fervants, though fhe cannot, with propriety, employ more than two. The houfes of gentlemen, and efpecially of grandees, fwarm with them; and, not unfrequently, all the principal fervants will have their wives and children lodged with them, and fupported by their mafter. We have heard of one nobleman who was at the daily expence of 120l. merely for the maintenance of his numerous retainers.

The Spaniards are fond of meeting in the evening in parties, which are often very numerous. On thefe occafions, the ladies as they arrive place themfelves in one room, and the gentlemen in another; or elfe the ladies range themfelves in a line along the fide of the room, the lady of the houfe always taking the loweft place next to the door, whilft the men remain ftanding, or feat themfelves on the oppofite fide. They remain feparated in this manner till the card parties are introduced. They play at loo, loto, and other games of a fimilar kind. Thofe who do not play, either look on, or embrace the opportunity of chatting with the perfon moft interefting to them. Others form little circles, where the converfation is ufually very animated. Thefe parties very much refemble the French evening, and the Englifh rout.

A *refrefco* fometimes makes part of thefe entertainments, but only on particular occafions, when the company is more than ufually numerous. But orgeat, lemonade, orangeade, ices of different kinds, fweetmeats, and bifcuits, are diftributed with uncommon profufion; and chocolate ends the *funcion*, as all thefe entertainments are called.

Many precautions are taken in Spain againft the heat. The rooms are watered feveral times a-day, and the windows are fhaded on the outfide with awnings of cloth or ticking, or on the infide by large and full curtains. In fome places, as at Valencia, the glafs is taken out of the windows at the approach of fummer, and the doors of the apartments are all fet open.

The beds in Spain are hard, being made of mattreffes, laid on paillaffes, refting on a wooden bottom. The furniture of the houfes is ufually very fimple, and the floors are covered with matting or printed cloth. The chairs have rufh bottoms, and are ufually of different heights, thofe for the ladies being one-third lower than thofe for the gentlemen.

224 Amufements.

Among the principal amufements of the Spaniards muft be reckoned mufic and dancing. Though the Spaniards have a tafte for mufic, they are by no means proficients in that accomplifhment. Their principal inftrument is the guitar, which is in the hands of every body. Different provinces have alfo their peculiar inftruments. Thus the Gallicians ufe a dull and heavy bagpipe; the Catalonians a large flageolet, and a little drum or tabor; and the Bifcayans a fhort flute, with four holes. Caftanettes are alfo extremely common, and are employed with great dexterity and addrefs in the national dances.

The Spaniards are paffionately fond of dancing, and they have certain dances which are peculiar to Spain. Of thefe the fandango is the moft celebrated, and appears to be the moft ancient. It is a very extraordinary dance, in which the whole body is thrown into a regular and harmonious convulfion, expreffive of the moft lafcivious ideas.

The paffion of the Spaniards for thefe dances is carried to a height which can fcarcely be imagined. No fooner are the guitar and the finging to which they are danced heard in a ball room or theatre, than a murmur of delight arifes on all fides; all faces become animated; the feet, hands, and eyes of all prefent are put in motion: it is impoffible to defcribe the effect produced. Mr Townfend, an Englifh traveller, affirms, that if a perfon were to come fuddenly into a church or a court of juftice playing the *fandango*, or the *colero*, priefts, judges, lawyers, criminals, audience, one and all, grave and gay, young or old, would quit their functions, forget all diftinctions, and all fet themfelves a dancing.

The Spanifh balls are directed by two perfons chofen among the vifitors, who are called *baftoneras*, and with the hat under the arm, and the cane in the hand, perform the office of mafters of the ceremonies. One is for the gentlemen, the other for the ladies. It is their bufinefs to appoint who is to dance, whether minuets or country dances: they are in general very attentive to the obfervance of precedence and etiquette, and have ufually the complaifance to contrive that thofe fhall dance together to whom it is peculiarly agreeable to meet.

A fingular cuftom is obferved at thefe balls, which appears new and ftrange to a foreigner. The lady chofen to dance rifes, croffes the room alone, and places herfelf where fhe is to begin dancing, without waiting for her partner to lead her out; and after the dance is over, her partner makes his bow to her again in the middle of the room without taking any further concern about her, or handing her back to her place. But this cuftom prevails only in the provinces.

The bull-fights noticed above were once not only a favourite but a fafhionable fpectacle in Spain. Every city, and almoft every fmall town, had a place fet apart for thefe darling combats; and hither all ranks and ages reforted with the greateft avidity, and witneffed the prowefs of the combatants, and the torture of the wretched animals, whom they were hired to butcher, with the moft favage expreffions of delight. Thefe fights made a part of every feftival, and, as foon as they were announced, the houfewife left her family, the tradefman forfook his fhop, the artift his work-room, the labourer his field, and joy and expectation were painted on every countenance. To the honour of the nation, thefe cruel fports are at length abolifhed, and Spain has thus fet an example of humanity, which Britain, with all her civilization and refinement, need not blufh to copy.

New-SPAIN.

Spalatro ‖ Spallanzani.

New-SPAIN. See MEXICO.

SPALATRO, or SPALATTO, a rich, populous, and ftrong town of the republic of Venice, capital of Venetian Dalmatia, with a good harbour and an archbifhop's fee. Here are the ruins of the palace of Dioclefian, of which the late Mr Robert Adam publifhed in 1764 a fplendid account, enriched with 71 folio plates. In 1784, Spalatro was nearly depopulated by the plague. It is ftrong by fituation, being built on a peninfula, which is joined to terra firma by a neck of land half a mile over. It is feated on the gulf of Venice, 35 miles fouth-eaft of Sebenico, and 102 north-weft of Ragufa. E. Long. 17. 31. N. Lat. 44. 4.

SPALLANZANI, LAZARUS, a celebrated naturalift, was born at Scandiano, in the duchy of Modena, in January 1729. He began his ftudies in his native country, and went to Reggio de Modena at 15 years of age, to profecute them further. He was inftructed in the *belles lettres* by the Jefuits, who contended with the Dominicans in order to fecure his attachment; but his thirft for knowledge determined him to go to Bologna, where his relative Laura Baffi, a woman highly celebrated for her genius, eloquence, and fkill in natural philofophy and mathematics, was one of the moft diftinguifhed profeffors of the Inftitute and of Italy. Under this enlightened guide, he was taught to prefer the ftudy of nature to that of her commentators, judging of the real value of the commentary by its refemblance to the original. He availed himfelf of the wifdom of that lady's counfels, the happy effects of which he very foon experienced. Spallanzani's tafte for philofophy was not exclufive, for he carefully ftudied his own language, became a proficient in the Latin tongue, and attached himfelf above every other to the Greek and French. By the advice of a father whom he ardently loved, he applied himfelf to jurifprudence; but being urged by Anthony Vallifnieri to renounce his vocation, by procuring the confent of his father, he gave himfelf up to the ftudy of mathematics with more zeal than ever, at the fame time devoting himfelf to the ftudy of languages, both living and dead.

It was not long before he was known all over Italy, and what is feldom the cafe, his own country firft put that value on his talents which they juftly merited. He was chofen profeffor of logic, metaphyfics and Greek, in the univerfity of Reggio, in the year 1745, where he taught during ten years, devoting every moment of his leifure time to the ftudy and contemplation of the works of nature. The attention of Haller and Bonnet was fixed by his obfervations on the animalculæ of infufions, the latter affifting him in his laudable career, and ever after diftinguifhed him as one of the learned interpreters of nature.

Spallanzani was invited to the univerfity of Modena in the year 1760, and fome years after he declined to accept of the offers made to him by the academy of Peterfburg, as well as fimilar ones from Coimbra, Parma, and Cefena, though extremely advantageous. He preferred his native fpot, and therefore continued at Modena till the year 1768, and faw raifed up by his care a generation of men conftituting at that time the glory of Italy, among whom we find Venturi, Belloni, Lucchefini, and Angelo Mazzo.

While Spallanzani remained at Modena, he publifhed his *Saggio di Offervazioni Microfcopiche concernente il Syftema di Needham e Buffon*, in 1765, in which he eftablifhes, by a number of the moft ingenious and folid experiments, the *animality of microfcopic animalculæ*. This work was fent by the author to Bonnet, who drew from it a prediction refpecting the future celebrity of Spallanzani, which he lived to fee accomplifhed. This circumftance gave birth to the moft intimate friendfhip, which lafted to the clofe of life, and conftituted their chief happinefs. During the fame year he publifhed a truly original work, entitled *De Lapidibus ab aqua refilientibus*, in which he proves, in oppofition to the commonly received opinion, by the moft fatisfactory experiments, that what are called *ducks* and *drakes*, are not produced by the elafticity of the water, but by the effect naturally refulting from the change of direction experienced by the ftone in its movement, after it has ftruck the water, and that it has been carried over the hollow of the cup formed by the concuffion.

When the univerfity of Padua was re-eftablifhed upon a larger fcale, the Count de Firmian was directed by the emprefs Maria Therefa, to invite Spallanzani to be profeffor of natural hiftory, to which his great reputation made him competent, although it was folicited by many celebrated characters; and he merited it by his fuccefs, as immenfe crowds of ftudents thronged to his lectures. He had a fine genius, and his knowledge was of vaft extent; his method was fimple, but rigorous in its nature, and what he knew he connected with principles firmly eftablifhed. He acquired the valuable art of interpreting nature by herfelf, which diffufed fuch a light over his lectures, that every thing became perfpicuous, which could be faid to afford any inftruction. His difcourfes were plain and animated, and the elegance and purity of his ftyle charmed every hearer. He prepared his lectures a year before hand, and it was his chief aim to render them ufeful in an eminent degree. His new obfervations made them always new and engaging. Many learned perfons who attended his lectures were not above becoming his fcholars, in order to acquire a more extenfive knowledge of what they knew before, and to learn that which otherwife they might probably never have known. The *Contemplation de la Nature* of Bonnet was his text book, the vacancies of which he ably filled up, fully explained the ideas, and eftablifhed the theories by his own experiments. This work was tranflated by him into the Italian language, and he added much to its value by notes of his own, the firft volume of which he publifhed in 1769, and the fecond the following year.

His connection with Bonnet tended, in a great meafure, to influence his genius, which yielded to the fevere method of inveftigation adopted by the philofopher of Geneva. He was proud of being the pupil of fuch an illuftrious character, upon whofe writings he inceffantly beftowed every leifure moment, and thus became anxious to learn from Nature herfelf the proofs of Bonnet's fentiments refpecting the generation of organized bodies, the pleafing nature of which refearch captivated his attention for a confiderable time.

The firft two volumes of this work entitled *Opufculi di Fifica Animale e Vegetabile*, were publifhed in the year 1776, containing the explanation of part of the microfcopic obfervations which were previoufly given to the world.

If it muft be admitted that the art of accurate obfer-

Spallanzani.

tion is by far the most difficult, it cannot be denied that it is at the same time the most necessary, and requires the most brilliant talents and abilities, which were possessed by Spallanzani in a remarkable degree, as is fully evinced by all his researches and all his admirable writings.

The polite manner in which he conducted his dispute with Needham respecting the phenomena of generation, secured for him a high degree of applause. On this occasion he treated of the influence of cold upon animals, and proved that the torpidity of some during winter, does not depend on the impression the blood may receive from it, since a frog deprived of blood, becomes torpid when reduced to the same cold state by being immersed in ice, and swims as formerly when restored to a proper degree of warmth.

Spallanzani travelled through Switzerland and the Grisons in the year 1779, after which he went to Geneva, spending a month with his friends, by whom his conversation was as much admired as his masterly writings. From this place he returned to Pavia, and in 1780 published two more volumes of his *Dissertazione di Fisica Animale e Vegetabile*, wherein he unfolded the secrets of the interpretation of two very intricate phenomena, concerning the economy of animals and vegetables. He was led to this study from some experiments made by him upon *digestion*, for his lectures; and he repeated the experiments of Reaumur on gallinaceous birds, remarking that the trituration which in this case is favourable to digestion, could not be a very powerful means. He perceived that the gizzard of those birds, by which the stones of fruit are pulverized, did not digest the powder thus formed, it being necessary that it should undergo a new operation in the stomach, previous to its becoming chyle for the production of the blood and other humours.

This subject may be regarded as one of the most difficult in physiology, because the observer is always under the necessity of acting and looking in the midst of darkness; the animal must be managed with care, that the derangement of the operations may be avoided; and when the experiments are completed with great labour, it is requisite that the consequences be well distinguished. Spallanzani in this work is truly enchanting, analysing facts with scrupulosity, in order to ascertain their causes with certainty; comparing Nature with his experiments, in order to form a correct judgement respecting them; laying hold of every thing essential to them in his observations, and measuring their solidity by the increase or diminution of supposed causes.

Mr John Hunter appears to have been greatly hurt by this work, which led him to publish, in the year 1785, *Some Observations upon Digestion*, in which he threw out some bitter sarcasms against the Italian naturalist, who took ample revenge by publishing this work in the Italian language, and addressing to Caldani in 1788, *Una Lettera Apologetica in Risposta alle Osservazione del Signor Giovanni Hunter*. In this he exposed with great moderation, but at the same time with logic which nothing could resist, the mistakes and errors of the British physiologist, leaving the power of a reply altogether hopeless.

The generation of animals and plants is treated of in the second volume of this last-mentioned work, in which he proves the pre-existence of germs to fecundation, by experiments as satisfactory as surprising; shewing also the existence of tadpoles in the females of five different species of frogs, in salamanders, and toads, before their fecundation. He likewise recounts the success of some artificial fecundations upon the tadpoles of those five species, and even upon a quadruped.

In the year 1781, he took the advantage of the academical vacation, for the purpose of making a journey, in order to add to the cabinet of Pavia. He set out for Marseilles in the month of July that year, where he began a new history of the sea, which presented him with many new and curious facts on numerous genera of the natives of the ocean. He went also to Finale, Genoa, Massa, and Carrara, to make observations on the quarries of marble, held by statuaries in such estimation. He then returned to Spezzia, and brought from thence to Pavia a vast number of fishes, which he deposited in the cabinet of that city, wholly collected by himself. With the same view and success he visited the coasts of Istria in 1782, and the Apennine mountains the subsequent year, taking notice of the dreadful hurricanes, and the astonishing vapours by which that year became so noted in meteorology. The emperor Joseph, on examining this cabinet presented Spallanzani with a gold medal. In 1785, he was offered the chair of natural history by the university of Padua, vacant by the death of Anthony Vallisnieri; but in order to prevent his acceptance of it, his salary was doubled by the archduke, and he went to Constantinople with Chevalier Zuliani, who had been appointed ambassador from the Venetian republic. He set out on the 21st of August, and reached the Turkish metropolis on the 11th of October, where he remained during eleven months. His attention was fixed by the physical and moral phenomena of this country, which were new even to Spallanzani. He strayed along the borders of the two seas, and ascended the mountains in the vicinity; he paid a visit to the island of Chalki, discovering to the Turks a copper mine, the existence of which they had never once conjectured. He discovered an iron mine not far from Constantinople, in the island of Principi, of which the Turks were equally ignorant, and prepared to return for Italy on the 16th of August 1786.

A voyage by sea was undoubtedly the safest, but the dangers to which he would be exposed by land were regarded as nothing when contrasted with the idea of being beneficial to science and to man. Having reached Bucharest, Mauroceni the friend of science, received Spallanzani with marks of distinction, presented him with many rarities which the country produced, and gave him horses for travelling, with an escort of 30 troopers, to the utmost confines of his own dominions. Our philosopher passed by Hermanstadt in Transylvania, and reached Vienna on the 7th of December, where he remained during five days, and had two long conferences with the emperor Joseph II. was much esteemed by the nobility of that city, and respectfully visited by many literary characters. When he arrived at Pavia, the students went out of the city gates to meet him, and testified their joy at his return by repeated acclamations. He was almost instantly drawn to the auditory, and compelled to ascend the chair from which he had been accustomed to deliver his fascinating lectures; but their demonstrations of joy and shouts of applause made him request of them to give over, and indulge him with

that

that repose in his own house which was now so absolutely necessary. His students this year exceeded 500.

So extensive was the fame of Spallanzani become by this time, that envy was determined, if possible, to wound his reputation. If his discoveries were too new, solid, and original, to be successfully disputed, that vile passion, or rather *fiend*, began to question his integrity and uprightness respecting the administration of the cabinet of Pavia; but this iniquitous attempt to tarnish his honour, only made it shine forth with redoubled splendour. The juridical examination of the tribunals made his integrity appear even purer than before; and it must be mentioned to his honour, that he had the fortitude to forget this event; his enemies in general confessed their mistake, renounced their unprovoked animosity, and still hoped to regain a friendship of which they had proved themselves so unworthy.

In the voyage of Spallanzani we meet with what may be denominated a new volcanology. We are there instructed how to measure the intensity of volcanic fires, and in his analysis of the lava, almost to touch the particular gas which tears those torrents of stone in fusion from the bowels of the earth, and raises them to the top of Mount Etna. This delightful work is closed by some important enquiries into the nature of Swallows, the mildness of their dispositions, the rapidity of their flight, discussing the celebrated problem respecting their remaining torpid during the winter season, proving that artificial cold, much more intense than what is ever naturally experienced in our climates, does not reduce these birds to the torpid state.

Things apparently impossible were often discovered by Spallanzani. In the year 1795 he made one of this description, which he gave to the world in his *Lettere sopra il sospetto d'un nuovo senso nei Pipistrelli*. In that work we are informed that bats, if deprived of sight, act with the same precision in every instance as those which have their eyes; that they shun in the same manner the most trivial obstacles, and also know where to fix themselves when their flight is terminated. Several philosophers confirmed these astonishing experiments, from which a suspicion arose, that these animals must have a new sense, as it appeared to Spallanzani that the other known senses could not compensate for the want of sight; but he was afterwards inclined to think, in consequence of Professor Jurine's experiments on the organ of hearing in bats, that in this particular instance the sense of hearing might possibly supply the want of sight.

The literary career of this celebrated naturalist was terminated by a letter to Giobert, entitled *Sopra la piante chiuse ne vasi dentro l'aqua e l'aria, esposte a l'immediata lume solare e a l'ombra*. These numerous works, which met with the highest approbation, do not comprehend the whole of his multifarious labours; for the phenomena of respiration had occupied his attention a considerable time; their points of resemblance and dissimilitude in many species of animals; and he had nearly finished his voyage to Constantinople, as well as collected many valuable materials for a history of the sea, when his life and labours were unfortunately terminated.

He was seized with a retention of urine on the 4th of February 1799, and next morning was deprived of the regular use of his faculties, only enjoying a sound mind during very short intervals. Tourdes and Professor Scarpa did every thing to save him, which could be produced by the joint exertions of genius, experience, and friendship, but in vain. He died on the 17th; but we know not what credit is due to the assertion, that he edified those around him during his last moments by his *piety*. Be that as it may, while his works exist to speak for themselves, impartial posterity will regard him as a very extraordinary man. These works have been translated into almost every European language, and he was admitted a member of the academies and learned societies of London, Stockholm, Gottingen, Holland, Lyons, Bologna, Turin, Padua, Mantua, and Geneva, and he received from Frederick the Great the diploma of member of the academy of Berlin.

SPAN, a measure taken from the space between the thumb and the tip of the little finger when both are stretched out. The span is estimated at three hand's-breadths or nine inches.

SPANDRELL, the solid work on each haunch of an arch, to keep it from spreading.

SPANHEIM, EZEKIEL, a learned writer in the 17th century, was born at Geneva in 1629; and in 1642 went to Leyden to study. Here he distinguished himself to great advantage; and his reputation spreading, Charles Louis elector palatine sent for him to be tutor to his only son. This task our author discharged to the entire satisfaction of the elector; by whom he was also employed in divers negotiations at foreign courts. He afterwards entered into the service of the elector of Brandenburg, who in 1680 sent him envoy extraordinary to the court of France, and soon after made him a minister of state. After the peace of Ryswic, he was again sent on an embassy to France where he continued from the year 1697 to 1702. The elector of Brandenburg having during that interval assumed the title of *King of Prussia*, conferred on him the title and dignity of a baron. In 1702 he left France; and went ambassador to England, where he had been several times. Here he died in 1710, aged 81 years. It is surprising, that in discharging the duties of a public minister with so much exactness, and amidst so many different journeys, he could find time enough to write the several books published by him. It may be said of him, that he acquitted himself in his negotiations like a person who had nothing else in his thoughts; and that he wrote like a man who had spent his whole time in his study. The principal of his works are, 1. *De præstantia et usu numismatum antiquorum;* the best edition of which is in two volumes folio. 2. Several letters or dissertations on scarce and curious medals. 3. A preface and notes to the edition of the emperor Julian's works, printed at Leipsic in 1696, folio.

SPANIEL, in *Zoology*. See CANIS, MAMMALIA, *Index*.

SPAR, in *Mineralogy*, a name given chiefly to some of the crystallized combinations of lime, as the carbonate and the fluate; the former being called simply *lime spar*, the latter fluor spar, or Derbyshire spar, from the name of the place where it is found in greatest abundance. See MINERALOGY.

SPARGANIUM, BUR-REED, a genus of plants belonging to the class of monœcia, and to the order of triandria; and in the natural system ranged under the 3d order, *Calamariæ*. See BOTANY *Index*.

SPARLING, or SPIRLING, a ſmall fiſh belonging to the genus *Salmo*. See ICHTHYOLOGY, p. 99.

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

SPARROW. See FRINGILLA, ORNITHOLOGY *Index*.

SPARROW-Hawk. See FALCO, ORNITHOLOGY *Index*.

SPARROW-Graſs. See ASPARAGUS, BOTANY and GARDENING *Index*.

SPARRY-ACID. See *FLUORIC-Acid*, CHEMISTRY *Index*.

SPARTA, or LACEDÆMON, the capital of the country of Laconia in Greece, an ancient and moſt renowned ſtate, the inhabitants of which have been in all ages celebrated for the ſingularity of their laws and character.—The hiſtory of Sparta for many ages is entirely fabulous; and the authentic accounts commence only with the celebrated lawgiver Lycurgus, who flouriſhed about 870 B. C. See the article LYCURGUS.

1 The hiſtory of Sparta moſtly fabulous till the time of Lycurgus.

After his death, the firſt important tranſaction which we find mentioned in the Spartan hiſtory is the Meſſenian war, which commenced in the year 752 B. C. and ended in the total reduction of the Meſſenian territory, as related under the article MESSENIA. During this period, according to ſome authors, a great change took place in the government of Sparta. This was the creation of the ephori, which is aſcribed to one of the kings named *Theopompus*. This man perceiving that there was a neceſſity for leaving magiſtrates to execute the laws, when the kings were obliged to be in the field, appointed the magiſtrates above mentioned, who afterwards made ſo great a figure in the ſtate (ſee EPHORI). One great privilege of the ephori was, that they did not riſe up at the preſence of the kings, as all other magiſtrates did: another was, that if the kings offended againſt the laws, the ephori took cognizance of the offence, and inflicted a ſuitable puniſhment. From the firſt election of the ephori, the year was denominated, as at Athens, from the firſt election of the archons.

The conqueſt of Meſſenia gave Sparta the ſuperiority over the reſt of the ſtates, excepting only that of Athens, which for a long time continued to be a very troubleſome rival: but the conteſts between theſe two rival ſtates have been ſo fully related under the article ATTICA, that nothing more is requiſite to be added in this place.—In the time of the Perſian war, Leonidas the Spartan king, diſtinguiſhed himſelf in ſuch a manner, as to become the admiration not only of that but of every ſucceding age. It being reſolved in a general council to defend the ſtraits of Thermopylæ againſt the Perſians, 7000 * foot were put under the command of Leonidas; of whom, however, only 300 were Spartans. Leonidas did not think it practicable to defend the paſs againſt ſuch multitudes as the Perſian king commanded; and therefore privately told his friends, that his deſign was to devote himſelf to death for his country.

2 Leonidas undertakes to defend the ſtraits of Thermopylæ againſt the Perſians.

* See *Anacharſis's Travels*, vol. [illegible] p. 463.

Xerxes advancing near the ſtraits, was ſtrangely ſurpriſed to find that the Greeks were reſolved to diſpute his paſſage; for he had always flattered himſelf, that on his approach they would betake themſelves to flight, and not attempt to oppoſe his innumerable forces. However, Xerxes ſtill entertaining ſome hopes of their flight, waited four days without undertaking any thing, on purpoſe to give them time to retreat. During this time, he uſed his utmoſt endeavours to gain and corrupt Leonidas, promiſing to make him maſter of all Greece if he would come over to his intereſt. His offers being rejected with contempt and indignation, the king ordered him by a herald to deliver up his arms. Leonidas, in a ſtyle and with a ſpirit truly laconical, anſwered, "Come thyſelf, and take them." Xerxes, at this reply, tranſported with rage, commanded the Medes and Ciſſians to march againſt them, take them all alive, and bring them to him in fetters. The Medes, not able to ſtand the ſhock of the Greeks, ſoon betook themſelves to flight: and in their room Hydarnes was ordered to advance with that body which was called *Immortal*, and conſiſted of 10,000 choſen men; but when theſe came to cloſe with the Greeks, they ſucceeded no better than the Medes and Ciſſians, being obliged to retire with great ſlaughter. The next day the Perſians, reflecting on the ſmall number of their enemies, and ſuppoſing ſo many of them to be wounded that they could not poſſibly maintain a ſecond fight, reſolved to make another attempt; but could not by any efforts make the Greeks give way: on the contrary, they were themſelves put to a ſhameful flight. The valour of the Greeks exerted itſelf on this occaſion in a manner ſo extraordinary, that Xerxes is ſaid to have three times leaped from his throne, apprehending the entire deſtruction of his army.

3 The Perſians repulſed with great ſlaughter.

Xerxes having loſt all hopes of forcing his way through troops that were determined to conquer or die, was extremely perplexed and doubtful what meaſures he ſhould take in this poſture of affairs; when one Epialtes, in expectation of a great reward, came to him, and diſcovered a ſecret paſſage to the top of the hill which overlooked and commanded the Spartan forces. The king immediately ordered Hydarnes thither with his ſelect body of 10,000 Perſians; who marching all night, arrived at break of day, and poſſeſſed themſelves of that advantageous poſt. The Phocæans, who defended this paſs, being overpowered by the enemy's numbers, retired with precipitation to the very top of the mountain, prepared to die gallantly. But Hydarnes neglecting to purſue them, marched down the mountain with all poſſible expedition, in order to attack thoſe who defended the ſtraits in the rear. Leonidas being now appriſed that it was impoſſible to bear up againſt the enemy, obliged the reſt of his allies to retire: but he ſtaid himſelf, with the Theſpians, Thebans, and 300 Lacedemonians, all reſolved to die with their leader; who being told by the oracle, that either Sparta ſhould be deſtroyed or the king loſe his life, determined without the leaſt heſitation to ſacrifice himſelf for his country. The Thebans indeed remained againſt their inclination, being detained by Leonidas as hoſtages; for they were ſuſpected to favour the Perſians. The Theſpians, with their leader Demophilus, could not by any means be prevailed upon to abandon Leonidas and the Spartans. The augur Megiſtias, who had foretold the event of this enterpriſe, being preſſed by Leonidas to retire, ſent home his only ſon; but remained himſelf, and died by Leonidas. Thoſe who ſtaid did not feed themſelves with any hopes of conquering or eſcaping, but looked upon Thermopylæ as their graves; and when Leonidas, exhorting them to take ſome nouriſhment, ſaid, that they ſhould

4 They are ſhown a way over the hill to ſurround the Greeks.

Sparta.

ſhould all ſup together with Pluto, with one accord they ſet up a ſhout of joy, as if they had been invited to a banquet.

5 Leonidas killed with all his men.

Xerxes, after pouring out a libation at the riſing of the ſun, began to move with the whole body of his army, as he had been adviſed by Epialtes. Upon their approach, Leonidas advanced to the broadeſt part of the paſſage, and fell upon the enemy with ſuch undaunted courage and reſolution, that the Perſian officers were obliged to ſtand behind the diviſions they commanded, in order to prevent the flight of their men. Great numbers of the enemy falling into the ſea, were drowned; others were trampled under foot by their own men, and a great many killed by the Greeks; who knowing they could not avoid death upon the arrival of thoſe who were advancing to fall upon their rear, exerted their utmoſt efforts. In this action fell the brave Leonidas; which Abrocomes and Hyperanthes, two of the brothers of Xerxes, obſerving, advanced with great reſolution to ſeize his body, and carry it in triumph to Xerxes. But the Lacedemonians, more eager to defend it than their own lives, repulſed the enemy four times, killed both the brothers of Xerxes, with many other commanders of diſtinction, and reſcued the body of their beloved general out of the enemy's hands. But in the mean time, the army that was led by the treacherous Epialtes, advancing to attack their rear, they retired to the narroweſt place of the paſſage, and drawing all together except the Thebans, poſted themſelves on a riſing ground. In this place they made head againſt the Perſians, who poured in upon them on all ſides, till at length, not vanquiſhed, but oppreſſed and overwhelmed by numbers, they all fell, except one who eſcaped to Sparta, where he was treated as a coward and traitor to his country; but afterwards made a glorious reparation in the battle of Platæa, where he diſtinguiſhed himſelf in an extraordinary manner. Some time after, a magnificent monument was erected at Thermopylæ, in honour of thoſe brave defenders of Greece, with two inſcriptions; the one general, and relating to all thoſe who died on this occaſion, importing, that the Greeks of Peloponneſus, to the number only of 4000, made head againſt the Perſian army, conſiſting of 3,000,000. The other related to the Spartans in particular, and was compoſed by the poet Simonides, to this purport: "Go, paſſenger, and acquaint the Spartans that we died here in obedience to their juſt commands." At thoſe tombs a funeral oration was yearly pronounced in honour of the dead heroes, and public games performed with great ſolemnity, wherein none but the Lacedemonians and Theſpians had any ſhare, to ſhow that they alone were concerned in the glorious defence of Thermopylæ.

6 A dreadful earthquake at Sparta.

At the end of the 77th Olympiad, a moſt dreadful earthquake happened at Sparta, in which, according to Diodorus, 20,000 perſons loſt their lives; and Plutarch tells us, that only five houſes were left ſtanding in the whole city. On this occaſion the Helotes or ſlaves, whom the Spartans had all along treated with the utmoſt cruelty, attempted to revenge themſelves, by taking up arms, and marching directly to the ruins of the city, in hopes of cutting off at once thoſe who had eſcaped from the earthquake. But in this they were prevented by the prudence of the Spartan king Archidamus; for he, obſerving that the citizens were more deſirous of preſerving their effects than taking care of their own lives, cauſed an alarm to be ſounded, as if he had known that an enemy was at hand. On this the citizens armed themſelves in haſte with ſuch weapons as they could come at; and having marched a little way from the city, met the Helotes, whom they ſoon compelled to retire. The latter, however, knowing that they had now no mercy to expect from thoſe who had alreaty treated them with ſuch cruelty, reſolved to defend themſelves to the laſt. Having therefore ſeized a ſea-port town in Meſſenia, they from thence made ſuch incurſions into the Spartan territories, that they compelled thoſe imperious maſters to aſk aſſiſtance from the Athenians. This was immediately granted; but when the Spartans ſaw that the ſkill of the Athenians in beſieging towns was much greater than their own, they became jealous, and diſmiſſed their allies, telling them, that they had now no farther occaſion for their ſervices. On this the Athenians left them in diſguſt; and as the Helotes and Meſſenians did not chooſe to come to an engagement with a Spartan army in the field, but took ſhelter in their fortified places, the war was protracted for ten years and upwards. At laſt the Helotes were reduced to their former miſery; and the Meſſenians were obliged to leave Peloponneſus, on pain of being made ſlaves alſo. Theſe poor people were then received by the Athenians, who granted them Naupactus for their reſidence, and afterwards brought them back to a part of their own country, from whence in the courſe of the Peloponneſian war they had driven the Spartans.

7 War with the Helotes.

8 With the Athenians and Perſians.

In the year 431 B. C. the Peloponneſian war commenced; of which a full account has been given under the article ATTICA, N° 116—165. It ended moſt unfortunately for the Athenians; their city being taken and diſmantled, as related in the article above mentioned. Thus were the Spartans raiſed to the higheſt pitch of glory; and, in the reign of Ageſilaus, they ſeemed to be on the point of ſubverting the Perſian empire, as related under the article PERSIA, N° 34. But here their good fortune and their views of empire were ſuddenly checked. Ageſilaus had carried on the war in Aſia with the greateſt ſucceſs; and as he would hearken to no terms of accommodation, a Perſian governor named *Tithrauſtes*, having firſt attempted in vain to bribe the king, diſpatched Timocrates the Rhodian with 50 talents into Greece, in order to try whether he could there meet with any perſons leſs incorruptible than the Spartan monarch. This agent found many who inclined to accept his offers; particularly in Thebes, Corinth, and Argos. By diſtributing the money in a proper manner, he inflamed the inhabitants of theſe three cities againſt the Spartans; and of all others the Thebans came into his terms with the greateſt readineſs. They ſaw that their antagoniſts would not of their own accord break with any of the ſtates of Greece, and did not chooſe to begin the war themſelves, becauſe the chiefs of the Perſian faction were unwilling to be accountable for the event. For this reaſon they perſuaded the Locrians to invade a ſmall diſtrict which lay in diſpute betwixt the Phocians and themſelves. On this the Phocians invaded Locris; the Locrians applied to the Thebans, and the Phocians to the Spartans. The latter were glad of an opportunity of breaking with the Thebans; but met with a much warmer reception than they expected. Their old general Lyſander, who had reduced

9 A general combination againſt Sparta.

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reduced Athens, was defeated and killed, with the loss of 1000 men: on which disaster Agesilaus was recalled, and obliged to relinquish all hopes of conquering the Persians. His return changed the fortune of the war so much, that all the states began to grow weary of a contest from which nobody derived any advantage except the king of Persia. In a short time a treaty was concluded, known in history by the name of the *peace of Antalcidas*. The terms of this treaty were highly disadvantageous and dishonourable to the Greeks *; for even the Spartans, though successful in Greece, had lost a great battle at sea with the Persian fleet under Conon the Athenian, which entirely broke their power in Asia.

10 Peace of Antalcidas.

* See *Persia*, n° 37.

By the peace of Antalcidas, the government of Bœotia was taken from the Thebans, which they had for a long time enjoyed; and by this they were so much provoked, that at first they absolutely refused to accede to the treaty; but as Agesilaus made great preparations to invade them, they thought proper at last to comply. However, it was not long before a new war commenced, which threatened the total subversion of the Spartan state. As, by the peace of Antalcidas, the king of Persia had in a manner guaranteed the sovereignty of Greece to Sparta, this republic very soon began to exercise its power to the utmost extent. The Mantineans were the first who felt the weight of their resentment, although they had been their allies and confederates. In order to have a pretence for making war against them, they commanded them to quit their city, and to retire into five old villages which, they said, had served their forefathers, and where they would live in peace themselves, and give no umbrage to their neighbours. This being refused, an army was sent against them to besiege their city. The siege was continued through the summer with very little success on the part of the Spartans; but having during the winter season dammed up the river on which the city stood, the water rose to such a height, as either to overflow or throw down the houses; which compelled the Mantineans to submit to the terms prescribed to them, and to retire into the old villages. The Spartan vengeance fell next on the Phliasians and Olynthians, whom they forced to come into such measures as they thought proper. After this they fell on the Thebans, and, by attempting to seize on the Piræum, drew the Athenians also into the quarrel. But here their career was stopped: the Thebans had been taught the art of war by Chabrias the Athenian; so that even Agesilaus himself took the command of the Spartan army in vain. At sea they were defeated by Timotheus the son of Conon; and by land the battle of Leuctra put an end to the superiority which Sparta had held over Greece for near 500 years. See Leuctra.

11 Hostilities r commenced.

12 The power of Sparta entirely broken.

After this dreadful defeat, the Spartans had occasion to exert all their courage and resolution. The women and nearest relations of those who were killed in battle, instead of spending their time in lamentations, shook each other by the hand, while the relations of those who had escaped from the battle hid themselves among the women; or if they were obliged to go abroad, they appeared in tattered clothes, with their arms folded, and their eyes fixed on the ground. It was a law among the Spartans, that such as fled from battle should be degraded from their honours, should be constrained to appear in garments patched with divers colours, to wear their beards half-shaved, and to suffer any to beat them who pleased, without resistance. At present, however, this law was dispensed with; and Agesilaus by his prudent conduct kept up the spirits of the people, at the same time that by his skill in military affairs he checked the progress of the enemy. Yet, during the lifetime of Epaminondas the Theban general, the war went on greatly to the disadvantage of the Spartans; but he being killed at the battle of Mantinea, all parties became quickly desirous of peace. Agesilaus did not long survive; and with him, we may say, perished the glory of Sparta. Soon after this all the states of Greece fell under the power of Alexander the Great; and the Spartans, as well as the rest, having become corrupt, and lost their martial spirit, became a prey to domestic tyrants, and to foreign invaders. They maintained their ground, however, with great resolution against the celebrated Pyrrhus king of Epirus; whom they repulsed for three days successively, though not without assistance from one of the captains of Antigonus. Soon after this, one of the kings of Sparta named *Agis*, perceiving the universal degeneracy that had taken place, made an attempt to restore the laws and discipline of Lycurgus, by which he supposed the state would be restored to its former glory. But though at first he met with some appearance of success, he was in a short time tried and condemned by the ephori as a traitor to his country. Cleomenes, however, who ascended the throne in 216 B. C. accomplished the reformation which Agis had attempted in vain. He suppressed the ephori; cancelled all debts; divided the lands equally, as they had been in the time of Lycurgus; and put an end to the luxury which prevailed among the citizens. But at last he was overborne by the number of enemies which surrounded him; and being defeated in battle by Antigonus, he fled to Egypt, where he put an end to his own life. With him perished every hope of retrieving the affairs of Sparta: the city for the present fell into the hands of Antigonus; after which a succession of tyrants took place; till at last all disturbances were ended by the Romans, who reduced Macedon and Greece to provinces of their empire, as has been related under these articles.

13 Agis and Cleomenes attempt in vain to restore it.

It remains now only to say something concerning the character, manners, and customs of the Spartans, which, as they were founded on the laws of Lycurgus, may best be learned from a view of these laws.

14 Institution of Lycurgus.

The institutions of Lycurgus were divided into 12 tables. The first comprehended such of the Spartan laws as regarded religion. The statues of all the gods and goddesses were represented in armour, even to Venus herself; the reason of which was, that the people might conceive a military life the most noble and honourable, and not attribute, as other nations did, sloth and luxury to the gods. As to sacrifices, they consisted of things of very small value; for which Lycurgus himself gave this reason, That want might never hinder them from worshipping the gods. They were forbidden to make long or rash prayers to the heavenly powers, and were injoined to ask no more than that they might live honestly and discharge their duty. Graves were permitted to be made within the bounds of the city, contrary to the custom of most of the Greek nations; nay, they buried close by their temples, that all degrees of

15 His laws concerning religion.

of people might be made familiar with death, and not conceive it ſuch a dreadful thing as it was generally eſteemed elſewhere: on the ſame account, the touching dead bodies, or aſſiſting at funerals, made none unclean, but were held to be as innocent and honourable duties as any other. There was nothing thrown into the grave with the dead body; magnificent ſepulchres were forbidden; neither was there ſo much as an inſcription, however plain or modeſt, permitted. Tears, ſighs, outcries, were not allowed in public, becauſe they were thought diſhonourable in Spartans, whom their lawgiver would have to bear all things with equanimity. Mourning was limited to 11 days; on the 12th the mourner ſacrificed to Ceres, and threw aſide his weeds. In favour of ſuch as were ſlain in the wars, however, and of women who devoted themſelves to a religious life, there was an exception allowed as to the rules before mentioned; for ſuch had a ſhort and decent inſcription on their tombs. When a number of Spartans fell in battle, at a diſtance from their country, many of them were buried together under one common tomb; but if they fell on the frontiers of their own ſtate, then their bodies were carefully carried back to Sparta, and interred in their family ſepulchres.

16 Concerning the diviſion of land.

II. Lycurgus divided all the country of Laconia into 30,000 equal ſhares: the city of Sparta he divided into 9000, as ſome ſay; into 6000, as others ſay; and as a third party will have it, into 4500. The intent of the legiſlator was, that property ſhould be equally divided among his citizens, ſo that none might be powerful enough to oppreſs his fellows, or any be in ſuch neceſſity, as to be therefrom in danger of corruption. With the ſame view he forbade the buying or ſelling theſe poſſeſſions. If a ſtranger acquired a right to any of theſe ſhares, he might quietly enjoy it, provided he ſubmitted to the laws of the republic. The city of Sparta was unwalled; Lycurgus truſting it rather to the virtue of its citizens than to the art of maſons. As to the houſes, they were very plain; for their ceilings could only be wrought by the axe, and their gates and doors only by the ſaw; and their utenſils were to be of a like ſtamp, that luxury might have no inſtruments among them.

17 Of the citizens, children, &c.

III. The citizens were to be neither more nor leſs than the number of city lots; and if at any time there happened to be more, they were to be led out in colonies. As to children, their laws were equally harſh and unreaſonable; for a father was directed to carry his new-born infant to a certain place, where the graveſt men of his tribe looked upon the infant; and if they perceived its limbs ſtraight, and thought it had a wholeſome look, they then returned it to its parents to be educated; otherwiſe it was thrown into a deep cavern at the foot of the mountain Taygetus. This law ſeems to have had one very good effect, viz. making women very careful, when they were with child, of either eating, drinking, or exerciſing, to exceſs: it made them alſo excellent nurſes; for which they were in mighty requeſt throughout Greece. Strangers were not allowed to reſide long in the city, that they might not corrupt the Spartans by teaching them new cuſtoms. Citizens were alſo forbidden to travel, for the ſame reaſon, unleſs the good of the ſtate required it. Such as were not bred up in their youth according to the law, were not allowed the liberty of the city, becauſe they held it unreaſonable, that one who had not ſubmitted to the laws in his youth ſhould receive the benefit of them when a man. They never preferred any ſtranger to a public office; but if at any time they had occaſion for a perſon not born a Spartan, they firſt made him a citizen, and then preferred him.

18 Of celibacy and marriage.

IV. Celibacy in men was infamous, and puniſhed in a moſt extraordinary manner; for the old bachelor was conſtrained to walk naked, in the depth of winter, through the market-place: while he did this, he was obliged to ſing a ſong in diſparagement of himſelf; and he had none of the honours paid him which otherwiſe belonged to old age, it being held unreaſonable, that the youth ſhould venerate him who was reſolved to leave none of his progeny behind him, to revere them when they grew old in their turn. The time of marriage was alſo fixed; and if a man did not marry when he was of full age, he was liable to an action; as were ſuch alſo as married above or below themſelves. Such as had three children had great immunities; ſuch as had four were free from all taxes whatſoever. Virgins were married without portions; becauſe neither want ſhould hinder a man, nor riches induce him, to marry contrary to his inclinations. When a marriage was agreed on, the huſband committed a kind of rape upon his bride. Huſbands went for a long time, ſecretly and by ſtealth, to the beds of their wives, that their love might not be quickly and eaſily extinguiſhed. Huſbands were allowed to lend their wives; but the kings were forbidden to take this liberty. Some other laws of the like nature there were, which as they were evidently againſt modeſty, ſo they were far from producing the end for which Lycurgus deſigned them; ſince, though the men of Sparta were generally remarkable for their virtue, the Spartan women were as generally decried for their boldneſs and contempt of decency.

19 Education of their children.

V. It was the care of Lycurgus, that, from their very birth, the Lacedemonians ſhould be inured to conquer their appetites: for this reaſon he directed, that nurſes ſhould accuſtom their children to ſpare meals, and now and then to faſting; that they ſhould carry them, when 12 or 13 years old, to thoſe who ſhould examine their education, and who ſhould carefully obſerve whether they were able to be in the dark alone, and whether they had got over all other follies and weakneſſes incident to children. He directed, that children of all ranks ſhould be brought up in the ſame way; and that none ſhould be more favoured in food than another, that they might not, even in their infancy, perceive any difference between poverty and riches, but conſider each other as equals, and even as brethren, to whom the ſame portions were aſſigned, and who, through the courſe of their lives, were to fare alike: the youths alone were allowed to eat fleſh: older men ate their black broth and pulſe; the lads ſlept together in chambers, and after a manner ſomewhat reſembling that ſtill in uſe in Turkey for the Janizaries: their beds, in the ſummer, were very hard, being compoſed of the reeds plucked by the hand from the banks of the Eurotas: in winter their beds were ſofter, but by no means downy, or fit to indulge immoderate ſleep. They ate altogether in public; and in caſe any abſtained from coming to the tables, they were fined. It was likewiſe ſtrictly forbidden for any to eat or drink at home before they came to the common meal; even then

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each had his proper portion, that every thing might be done there with gravity and decency. The black broth was the great rarity of the Spartans, which was compofed of falt, vinegar, blood, &c. fo that, in our times, it would be efteemed a very unfavoury foup. If they were moderate in their eating, they were fo in their drinking alfo; thirft was the fole meafure thereof; and never any Lacedemonian thought of drinking for pleafure: as for drunkennefs, it was both infamous and feverely punifhed; and, that young men might perceive the reafon, flaves were compelled to drink to excefs, that the beaftlinefs of the vice might appear. When they retired from the public meal, they were not allowed any torches or lights, becaufe it was expected, that men who were perfectly fober fhould be able to find their way in the dark: and, befides, it gave them a facility of marching without light; a thing wonderfully ufeful to them in time of war.

20 Of their diet, clothing, &c.

VI. As the poor ate as well as the rich, fo the rich could wear nothing better than the poor: they neither changed their fafhion nor the materials of their garments; they were made for warmth and ftrength, not for gallantry and fhow: and to this cuftom even their kings conformed, who wore nothing gaudy in right of their dignity, but were contented that their virtue fhould diftinguifh them rather than their clothes. The youths wore a tunic till they were twelve years old; afterwards they had a cloak given them, which was to ferve them a year: and their clothing was, in general, fo thin, that a Lacedemonian veft became proverbial. Boys were always ufed to go without fhoes; but when they grew up, they were indulged with them, if the manner of life they led required it; but they were always inured to run without them, as alfo to climb up and flip down fteep places with bare feet: nay, the very fhoe they ufed was of a particular form, plain and ftrong. Boys were not permitted to wear their hair; but when they arrived at the age of twenty, they fuffered their hair and beard to grow. Baths and anointing were not much in ufe among the Lacedemonians; the river Eurotas fupplied the former, and exercife the latter. In the field, however, their fumptuary laws did not take place fo ftrictly as in the city; for when they went to war, they wore purple habits; they put on crowns when they were about to engage the enemy; they had alfo rings, but they were of iron; which metal was moft efteemed by this nation. Young women wore their vefts or jerkins only to their knees, or, as fome think, not quite fo low; a cuftom which both Greek and Roman authors cenfure as indecent. Gold, precious ftones, and other coftly ornaments, were permitted only to common women; which permiffion was the ftrongeft prohibition to women of virtue, or who affected to be thought virtuous. Virgins went abroad without veils, with which married women, on the contrary were always covered. In certain public exercifes, in which girls were admitted as well as boys, they were both obliged to perform naked. Plutarch apologifes for this cuftom, urging, that there could be no danger from nakednefs to the morals of youth whofe minds were fortified and habituated to virtue. One of Lycurgus's principal views in his inftitutions, was to eradicate the very feeds of civil diffenfion in his republic. Hence proceeded the equal divifion of eftates injoined by him; hence the contempt of wealth, and the neglect of other diftinctions, as particularly birth, he confidering the people of his whole ftate as one great family; diftinctions which, in other commonwealths, frequently produce tumults and confufions that fhake their very foundation.

21 Obedience to their fuperiors.

VII. Though the Spartans were always free, yet it was with this reftriction, that they were fubfervient to their own laws, which bound them as ftrictly in the city as foldiers, in other ftates, were bound by the rules of war in the camp. In the firft place, ftrict obedience to their fuperiors was the great thing required in Sparta. This they looked upon as the very bafis of government; without which neither laws nor magiftrates availed much. Old age was an indubitable title to honour in Sparta: to the old men the youth rofe up whenever they came into any public place; they gave way to them when they met them in the ftreets, and were filent whenever their elders fpoke. As all children were looked upon as the children of the ftate, fo all the old men had the authority of parents: they reprehended whatever they faw amifs, not only in their own, but in other people's children: and by this method Lycurgus provided, that as youth are everywhere apt to offend, they might be nowhere without a monitor. The laws went ftill further: if an old man was prefent where a young one committed a fault, and did not reprove him, he was punifhed equally with the delinquent. Amongft the youths there was one of their own body, or at moft two years older than the reft, who was ftyled *iren:* he had authority to queftion all their actions, to look ftrictly to their behaviour, and to punifh them if they did amifs; neither were their punifhments light, but, on the contrary, very fevere; whereby the youth were made hardy, and accuftomed to bear ftripes and rough ufage. Silence was a thing highly commended at Sparta, where modefty was held to be a moft becoming virtue in young people; nor was it reftrained only to their words and actions, but to their very looks and geftures; Lycurgus having particularly directed, that they fhould look forward, or on the ground, and that they fhould always keep their hands within their robes. A ftupid inconfiderate perfon, one who would not liften to inftruction, but was carelefs of whatever the world might fay of him, the Lacedemonians treated as a fcandal to human nature; with fuch a one they would not converfe, but threw him off as a rotten-branch and worthlefs member of fociety.

22 Learning.

VIII. The plainnefs of their manners, and their being fo very much addicted to war, made the Lacedemonians lefs fond of the fciences than the reft of the Greeks. A foldier was the only reputable profeffion in Sparta; a mechanic or hufbandman was thought a low fellow. The reafon of this was, that they imagined profeffions which required much labour, fome conftant pofture, being continually in the houfe, or always about a fire, weakened the body and depreffed the mind: whereas a man brought up hardily, was equally fit to attend the fervice of the republic in time of peace, and to fight its battles when engaged in war. Such occupations as were neceffary to be followed for the benefit of the whole, as hufbandry, agriculture, and the like, were left to their flaves the Helotes; but for curious arts, and fuch as ferved only to luxury, they would not fo much as fuffer them to be introduced in their city; in confequence of which, rhetoricians, augurs, Sparta. gurs, bankers, and dealers in money, were ſhut out. The Spartans admitted not any of the theatrical diverſions among them; they would not bear the repreſentation of evil even to produce good; but other kinds of poetry were admitted, provided the magiſtrates had the peruſal of pieces before they were handed to the public.

Above all things, they affected brevity of ſpeech, and accuſtomed their children, from their very infancy, never to expreſs themſelves in more words than were ſtrictly neceſſary; whence a conciſe and ſententious oratory is to this day ſtyled *Laconic*. In writing they uſed the ſame conciſeneſs; of which we have a ſignal inſtance in a letter of Archidamus to the Eleans, when he underſtood that they had ſome thoughts of aſſiſting the Arcadians. It ran thus: "Archidamus to the Eleans: It is good to be quiet." And therefore Epaminondas thought that he had reaſon to glory in having forced the Spartans to abandon their monoſyllables, and to lengthen their diſcourſes.

The greateſt part of their education conſiſted in giving their youth right ideas of men and things: the iren or maſter propoſed queſtions, and either commended the anſwers that were made him, or reproved ſuch as anſwered weakly. In theſe queſtions, all matters, either of a trivial or abſtruſe nature, were equally avoided; and they were confined to ſuch points as were of the higheſt importance in civil life; ſuch as, Who was the beſt man in the city? wherein lay the merit of ſuch an action? and, Whether this or that hero's fame was well-founded? Harmleſs raillery was greatly encouraged; and this, joined to their ſhort manner of ſpeaking, rendered laconic replies univerſally admired.

Muſic was much encouraged; but in this, as in other things, they adhered to that which had been in favour with their anceſtors; nay, they were ſo ſtrict therein, that they would not permit their ſlaves to learn either the tune or the words of their moſt admired odes; or, which is all one, they would not permit them to ſing them if they had learned them. Though the youth of the male ſex were much cheriſhed and beloved, as thoſe that were to build up and continue the future glory of the ſtate, yet in Sparta it was a virtuous and modeſt affection, untinged with that ſenſuality which was ſo ſcandalous at Athens. The good effects of this part of Lycurgus's inſtitutions were ſeen in the union that reigned among his citizens; and which was ſo extraordinary, that even in caſes of competition, it was hardly known that rivals bore ill-will to each other; but, on the contrary, their love to the ſame perſon begat a ſecondary friendſhip among themſelves, and united them in all things which might be for the benefit of the perſon beloved.

Some authors have accuſed this great lawgiver of encouraging theft in his inſtitutions; which, they ſay, was not held ſcandalous among the Spartans, if it were ſo dexterouſly managed as that the perſon was not detected in it. But this is certain, and ſeems to be a ſtrong contradiction of the heinous charge, that when a theft was diſcovered, it was puniſhed with the utmoſt ſeverity: a perſon even ſuſpected of it would endure the heavieſt puniſhments rather than acknowledge it, and be branded with ſo baſe a crime.

23 Exerciſes.

IX. The exerciſes inſtituted by law fall under the ninth table. In theſe all the Greeks were extremely careful, but the Lacedemonians in a degree beyond the reſt; for if a youth, by his corpulence, or any other means, became unfit for theſe exerciſes, he underwent public contempt at leaſt, if not baniſhment.—Hunting was the uſual diverſion of their children; nay, it was made a part of their education, becauſe it had a tendency to ſtrengthen their limbs, and to render thoſe who practiſed it ſupple and fleet: they likewiſe bred up dogs for hunting with great care. They had a kind of public dances, in which they exceedingly delighted, and which were common alike to virgins and young men: indeed, in all their ſports, girls were allowed to divert themſelves with the youths: inſomuch, that, at darting, throwing the quoit, pitching the bar, and ſuch like robuſt diverſions, the women were as dexterous as the men. For the manifeſt oddity of this proceeding, Lycurgus aſſigned no other reaſon, than that he ſought to render women, as well as men, ſtrong and healthy, that the children they brought forth might be ſo too. Violent exerciſes, and a laborious kind of life, were only enjoined the youth; for when they were grown up to men's eſtate, that is, were upwards of 30 years old, they were exempted from all kinds of labour, and employed themſelves wholly either in affairs of ſtate or in war. They had a method of whipping, at a certain time, young men in the temple of Diana, and about her altar; which, however palliated, was certainly unnatural and cruel. It was eſteemed a great honour to ſuſtain theſe flagellations without weeping, groaning, or ſhowing any ſenſe of pain; and the thirſt of glory was ſo ſtrong in theſe young minds, that they very frequently ſuffered death without ſhedding a tear or breathing a ſigh. A deſire of overcoming all the weakneſſes of human nature, and thereby rendering his Spartans not only ſuperior to their neighbours, but to their ſpecies, runs through many of the inſtitutions of Lycurgus; which principle, if well attended to, thoroughly explains them, and without attending to which it is impoſſible to give any account of them at all.

24 Money, &c.

X. Gold and ſilver were, by the conſtitutions of Lycurgus, made of no value in Sparta. He was ſo well apprized of the danger of riches, that he made the very poſſeſſion of them venal; but as there was no living without ſome ſort of money, that is, ſome common meaſure or ſtandard of the worth of things, he directed an iron coinage, whereby the Spartans were ſupplied with the uſeful money, and at the ſame time had no temptation to covetouſneſs afforded them; for a very ſmall ſum was ſufficient to load a couple of horſes, and a great one muſt have been kept in a barn or warehouſe. The introduction of all foreign money was alſo prohibited, that corruption might not enter under the name of commerce. The moſt ancient method of dealing, viz. by barter, or exchange of one commodity for another, was preſerved by law in Sparta long after it had gone into diſuſe everywhere elſe. Intereſt was a thing forbidden in the Spartan commonwealth; where they had alſo a law againſt alienation of lands, accepting preſents from foreigners, even without the limits of their own country, and when their authority and character might well ſeem to excuſe them.

25 Courts of juſtice.

XI. Such of the laws of Sparta as related to courts of juſtice may be brought under the 11th table. Thirty years muſt have paſſed over the head of him who had a right to concern himſelf in juridical proceedings. Young

Young men were thought unfit for them; and it was even held indecent, and of ill report, for a man to have any fondnefs for law-fuits, or to be bufying himfelf at the tribunals, when he had no affairs there of his own. By thefe rules Lycurgus thought to fhut out litigioufnefs, and to prevent that multiplicity of fuits which is always fcandalous in a ftate. As young people were not permitted to inquire about the laws of other countries, and as they were hindered from hearing judicial proceedings in their courts, fo they were likewife forbidden to afk any queftions about, or to endeavour to difcover, the reafons of the laws by which themfelves were governed. Obedience was their duty; and to that alone they would have them kept. Men of abandoned characters, or who were notorioufly of ill fame, loft all right of giving their votes in refpect of public affairs, or of fpeaking in public affemblies; for they would not believe that an ill man in private life could mean his country better than he did his neighbour.

26 Military fervice.

XII. Till a man was 30 years old, he was not capable of ferving in the army, as the beft authors agree; though fome think that the military age is not well afcertained by ancient writers. They were forbidden to march at any time before the full-moon; the reafon of which law is very hard to be difcovered, if indeed it had any reafon at all, or was not rather founded on fome fuperftitious opinion, that this was a more lucky conjuncture than any other. They were likewife forbidden to fight often againft the fame enemy; which was one of the wifeft maxims in the political fyftem of Lycurgus: and Agefilaus, by offending againft it, deftroyed the power of his country, and loft her that authority which for many ages fhe maintained over the reft of Greece; for, by continually warring againft the Thebans, to whom he had an inveterate hatred, he at laft beat them into the knowledge of the art of war, and enabled them, under the command of Epaminondas, to maintain for a time the principality of Greece. Maritime affairs they were forbidden to meddle with, though the neceffity of things compelled them, in procefs of time, to tranfgrefs this inftitution, and by degrees to transfer to themfelves the dominion of the fea as well as of the land: but, after the Peloponnefian war, they again neglected naval affairs from a perfuafion that failors and ftrangers corrupted thofe with whom they converfed. As they never fortified Sparta, they were not ready to undertake fieges: fighting in the field was their proper province, and, while they could overcome their enemies there, they rightly conceived that nothing could hurt them at home. In time of war they relaxed fomewhat of their ftrict manner of living, in which they were fingular. The true reafon for this was, in all probability, that war might be lefs burdenfome to them; for, as we have more than once obferved, a ftrong defire to render them bold and warlike was the reigning paffion of their legiflator. They were forbidden to remain long encamped in the fame place, as well to hinder their being furprifed, as that they might be more troublefome to their enemies, by wafting every corner of their country. They flept all night in their armour; but their outguards were not allowed their fhields, that, being unprovided of defence, they might not dare to fleep. In all expeditions they were careful in the performance of religious rites; and, after their evening meal was over, the foldiers fung together hymns to their gods. When they were about to engage, the king facrificed to the mufes, that, by their affiftance, they might be enabled to perform deeds worthy of being recorded to lateft times. Then the army advanced in order to the found of flutes, which played the hymn of Caftor. The king himfelf fung the pæan, which was the fignal to charge. This was done with all the folemnity imaginable; and the foldiers were fure either to conquer or die: indeed they had no other choice; for if they fled they were infamous, and in danger of being flain, even by their own mothers, for difgracing their families. In this confifted all the excellency of the Spartan women, who, if poffible, exceeded in bravery the men, never lamenting over hufbands or fons, if they died honourably in the field; but deploring the fhame brought on their houfe, if either the one or the other efcaped by flight. The throwing away a fhield alfo induced infamy; and, with refpect to this, mothers, when they embraced their departing fons, were wont to caution them, that they fhould either return armed as they were, or be brought back fo when they were dead; for, as we have obferved, fuch as were flain in battle were neverthelefs buried in their own country. When they made their enemies fly, they purfued no longer than till victory was certain; becaufe they would feem to fight rather for the honour of conquering, than of putting their enemies to death. According to their excellent rules of war, they were bound not to fpoil the dead bodies of their enemies; but in procefs of time, this, and indeed many other of their moft excellent regulations, fell into defuetude. He who overcame by ftratagem, offered up an ox to Mars; whereas he who conquered by force, offered up only a cock; the former being efteemed more manly than the latter. After 40 years fervice, a man was, by law, no longer required to go into the field; and confequently, if the military age was 30, the Spartans were not held invalids till they were 70.

SPARTIANUS, Ælius, a Latin hiftorian, who wrote the lives of Adrian, Caracalla, and four other Roman emperors. He lived under the reign of Dioclefian, about the year 290.

SPARTIUM, Broom, a genus of plants belonging to the clafs of diadelphia, and order of decandria; and in the natural fyftem arranged under the 32d order, *Papilionaceæ*. See Botany *Index*.

The flower buds are in fome countries pickled, and eaten as capers; and the feeds have been ufed as a bad fubftitute for coffee. The branches are ufed for making befoms, and tanning leather. They are alfo ufed inftead of thatch to cover houfes. The old wood furnifhes the cabinet-maker with beautiful materials for vaneering. The tender branches are in fome places mixed with hops for brewing, and the macerated bark may be manufactured into cloth.

The *junceum*, or Spanifh broom, grows naturally in the fouthern provinces of France, as well as in other parts of the fouth of Europe. It grows in the pooreft foils, on the fteepeft declivities of the hills, in a ftony foil, where hardly any other plant could vegetate. In a few years it makes a vigorous fhrub; infinuating its roots between the interftices of the ftones, it binds the foil, and retains the fmall portion of vegetable earth fcattered over thefe hills, which the autumnal rains would other- *Journal de Phyfique.*

wife

wife wash away. It is most easily raised from seed, which is usually sown in January, after the ground has received a slight dressing.

The shrub serves two useful purposes. Its branches yield a thread of which linen is made, and in winter support sheep and goats.

In manufacturing thread from broom, the youngest plants are cut in the month of August, or after harvest, and gathered together in bundles, which at first are laid in the sun to dry: they are then beaten with a piece of wood, washed in a river or pond, and left to steep in the water for about four hours. The bundles thus prepared are taken to a little distance from the water, and laid in a hollow place made for them, where they are covered with fern or straw, and remain thus to steep for eight or nine days; during which time, all that is necessary, is to throw a little water once a-day on the heap, without uncovering the broom. After this, the bundles are well washed, the green rind of the plant or epidermis comes off, and the fibrous part remains; each bundle is then beaten with a wooden hammer upon a stone, to detach all the threads, which are at the same time carefully drawn to the extremity of the branches. After this operation, the faggots are untied, and spread upon stones or rocks till they are dry. The twigs must not be peeled till they are perfectly dry; they are then dressed with the comb, and the threads are separated according to the fineness, and spun upon a wheel.

The linen made of this thread serves various purposes in rural economy. The coarsest is employed in making sacks and other strong cloths for carrying grain or seeds. Of the finest is made bed, table, and body linen. The peasants in several places use no other, for they are unacquainted with the culture of hemp or flax, their soil being too dry and too barren for raising them. The cloth made with the thread of the broom is very useful; it is as soft as that made of hemp; and it would perhaps look as well as that made of flax if it was more carefully spun. It becomes white in proportion as it is steeped. The price of the finest thread, when it is sold, which seldom happens, is generally about a shilling a pound.

The other use to which this broom is applied, is to maintain sheep and goats during winter. In the mountains of Lower Languedoc these animals have no other food from November to April, except the leaves of trees preserved. The branches of this broom therefore are a resource the more precious, that it is the only fresh nourishment which at that season the flocks can procure, and they prefer it at all times to every other plant. In fine weather the sheep are led out to feed on the broom where it grows; but in bad weather the shepherds cut the branches, and bring them to the sheep folds. There is, however, an inconvenience attending the continued use of this food. It generally produces inflammation in the urinary passages. But this inconvenience is easily removed by cooling drink, or a change of food, or by mixing the broom with something else.

It is perhaps needless to add, that it differs much from the broom that is common everywhere in the north of Europe, though this too, in many places, is used for food to cattle. Both of them produce flowers that are very much resorted to by bees, as they contain a great quantity of honey juice. And this should be another inducement to the cultivation of the Spanish broom.

SPARUS, Gilthead, a genus of fishes belonging to the order of *thoracici*. See Ichthyology *Index*. The sparus auratus, or gilthead, was well known to the Romans, who did not esteem them unless they were fed with Lucrine oysters, as Martial informs us,

Non omnis laudem pretiumque AURATA meretur,
Sed qui solus erit concha Lucrina cibus.
Lib. xiii. Ep. 90.

SPASM, a convulsion. See Medicine, n° 278.

SPATHA, in *Botany*, a sheath; a species of calyx which bursts lengthwise, and protrudes a stalk supporting one or more flowers, which commonly have no perianthium or flower-cup.

SPATHACEÆ (from *spatha*, "a sheath"), the name of the ninth order in Linnæus's Fragments of a Natural Method, consisting of plants whose flowers are protruded from a spatha or sheath. See Botany *Index*.

SPATHELIA, a genus of plants belonging to the class of pentandria, and to the order of trigynia. See Botany *Index*.

SPAW. See Spa.

SPAWN, in *Natural History*, the eggs of fishes or frogs.

SPAVENTO. See Scanto.

SPAVIN, in the manege, a disease in horses, being a swelling or stiffness, usually in the ham, occasioning a lameness. See Farriery *Index*.

SPAYING, or Spading, the operation of castrating the females of several kinds of animals, as sows, bitches, &c. to prevent any further conception, and promote their fattening. It is performed by cutting them in the mid flank, on the left side, with a sharp knife or lancet, taking out the uterus, and cutting it off, and so stitching up the wound, anointing the part with tar, and keeping the animal warm for two or three days. The usual way is to make the incision aslope, two inches and a half long; that the fore-finger may be put in towards the back, to feel for the ovaries, which are two kernels as big as acorns on both sides of the uterus, one of which is drawn to the wound, and thus both taken out.

SPEAKER *of the House of Commons*, a member of the house elected by a majority of notes thereof to act as chairman or president in putting questions, reading briefs, or bills, keeping order, reprimanding the refractory, adjourning the house, &c. See Parliament.

SPEAKING, the art or act of expressing one's thoughts in articulate sounds or words. See Grammar, Language, Reading, and Oratory, Part iv.

Speaking-Trumpet. See Trumpet.

SPEAR-Mint. See Mentha, Botany *Index*.

Spear-Wort. See Ranunculus, Botany *Index*.

SPECIAL, something that is particular, or has a particular designation; from the Latin *species*, in opposition to the *general*, from *genus*.

SPECIES, in *Logic*, a relative term, expressing an idea which is comprised under some general one called a *genus*. See Logic, N° 68.

Species, in *Commerce*, the several pieces of gold, silver, copper, &c. which having passed their full preparation

preparation and coinage, are current in public. See MONEY.

SPECIES, in *Algebra*, are the letters, fymbols, marks, or characters, which reprefent the quantities in any operation or equation. This fhort and advantageous way of notation was chiefly introduced by Vieta, about the year 1590; and by means of it he made many difcoveries in algebra, not before taken notice of.

SPECIES, in *Optics*, the image painted on the retina by the rays of light reflected from the feveral points of the furface of an object, received by the pupil, and collected in their paffage through the cryftalline, &c.

It has been a matter of difpute among philofophers, whether the fpecies of objects which give the foul an occafion of feeing, be an effufion of the fubftance of the body; a mere impreffion which they make on all bodies under certain circumftances; or whether they are not fome more fubtile body, fuch as light. The moderns have decided this point by the invention of artificial eyes, in which the fpecies of objects are received on paper, in the fame manner as in the natural eye.

SPECIFIC, in *Philofophy*, that which is peculiar to any thing, and diftinguifhes it from all others.

SPECIFICS, in *Medicine*. By fpecifics is not meant fuch as infallibly and in all patients produce falutary effects. Such medicines are not to be expected, becaufe the operations and effects of remedies are not formally inherent in them, but depend upon the mutual action and reaction of the body and medicine upon each other; hence the various effects of the fame medicine in the fame kind of diforders in different patients, and in the fame patient at different times. By fpecific medicines we underftand fuch medicines as are found to be more uniform in their effects than others in any particular diforder.

SPECIFIC Gravity, is a term much employed in the difcuffions of modern phyfics. It expreffes the weight of any particular kind of matter, as compared with the weight of the fame bulk of fome other body of which the weight is fuppofed to be familiarly known, and is therefore taken for the ftandard of comparifon. The body generally made ufe of for this purpofe is pure water.

The fpecific gravity of bodies is a very interefting queftion both to the philofopher and to the man of bufinefs. The philofopher confiders the weights of bodies as meafures of the number of material atoms, or the quantity of matter which they contain. This he does on the fuppofition that every atom of matter is of the fame weight, whatever may be its fenfible form. This fuppofition, however, is made by him with caution, and he has recourfe to fpecific gravity for afcertaining its truth in various ways. This fhall be confidered by and by. The man of bufinefs entertains no doubt of the matter, and proceeds on it as a fure guide in his moft interefting tranfactions. We meafure commodities of various kinds by tons, pounds, and ounces, in the fame manner as we meafure them by yards, feet, and inches, or by bufhels, gallons, and pints; nay, we do this with much greater confidence, and prefer this meafurement to all others, whenever we are much interefted to know the exact proportions of matter that bodies contain. The weight of a quantity of grain is allowed to inform us much more exactly of its real quantity of ufeful matter than the moft accurate meafure of its bulk. We fee many circumftances which can vary the bulk of a quantity of matter, and thefe are frequently fuch as we cannot regulate or prevent; but we know very few indeed that can make any fenfible change in this weight without the addition or abftraction of other matter. Even taking it to the fummit of a high mountain, or from the equator to the polar region, will make no change in its weight as it is afcertained by the balance, becaufe there is the fame real diminution of weight in the pounds and ounces ufed in the examination.

Notwithftanding the unavoidable change which heat and cold make in the bulk of bodies, and the permanent varieties of the fame kind of matter which are caufed by different circumftances of growth, texture, &c. moft kinds of matter have a certain conftancy in the denfity of their particles, and therefore in the weight of a given bulk. Thus the purity of gold, and its degree of adulteration, may be inferred from its weight, it being purer in proportion as it is more denfe. The denfity, therefore, of different kinds of tangible matter becomes characteriftic of the kind, and a teft of its purity; it marks a particular appearance in which matter exifts, and may therefore be called, with propriety, SPECIFIC.

But this denfity cannot be directly obferved. It is not by comparing the diftances between the atoms of matter in gold and in water that we fay the firft is 19 times denfer than the laft, and that an inch of gold contains 19 times as many material atoms as an inch of water; we reckon on the equal gravitation of every atom of matter whether of gold or of water; therefore the weight of any body becomes the indication of its material denfity, and the weight of a given bulk becomes fpecific of that kind of matter, marking its kind, and even afcertaining its purity in this form.

It is evident that, in order to make this comparifon of general ufe, the ftandard muft be familiarly known, and muft be very uniform in its denfity, and the comparifon of bulk and denfity muft be eafy and accurate. The moft obvious method would be to form, with all nicety, a piece of the ftandard matter of fome convenient bulk, and to weigh it very exactly, and keep a note of its weight: then, to make the comparifon of any other fubftance, it muft be made into a mafs of the fame precife bulk, and weighed with equal care; and the moft convenient way of expreffing the fpecific gravity would be to confider the weight of the ftandard as unity, and then the number expreffing the fpecific gravity is the number of times that the weight of the ftandard is contained in that of the other fubftance. This comparifon is moft eafily and accurately made in fluids. We have only to make a veffel of known dimenfions equal to that of the ftandard which we employ, and to weigh it when empty, and then when filled with the fluid. Nay, the moft difficult part of the procefs, the making a veffel of the precife dimenfions of the ftandard, may be avoided, by ufing fome fluid fubftance for a ftandard. Any veffel will then do; and we may enfure very great accuracy by ufing a veffel with a flender neck, fuch as a phial or matrafs; for when this is filled to a certain mark in the neck, any error in the eftimation by the eye will bear a very fmall proportion to the whole. The weight of the ftandard fluid which fills it to this mark being carefully afcertained, is kept in remembrance. The fpecific gravity of any other fluid is had by weighing the contents of this veffel when filled with it, and dividing

dividing the weight by the weight of the ſtandard. The quotient is the ſpecific gravity of the fluid. But in all other caſes this is a very difficult problem : it requires very nice hands, and an accurate eye, to make two bodies of the ſame bulk. An error of one hundredth part in the linear dimenſions of a ſolid body makes an error of a 30th part in its bulk; and bodies of irregular ſhapes and friable ſubſtance, ſuch as the ores of metals, cannot be brought into convenient and exact dimenſions for meaſurement.

From all theſe inconveniences and difficulties we are freed by the celebrated Archimedes, who, from the principles of hydroſtatics diſcovered or eſtabliſhed by him, deduced the accurate and eaſy method which is now univerſally practiſed for diſcovering the ſpecific gravity and denſity of bodies. (See ARCHIMEDES and HYDRODYNAMICS). Inſtead of meaſuring the bulk of the body by that of the diſplaced fluid (which would have been impoſſible for Archimedes to do with any thing like the neceſſary preciſion), we have only to obſerve the loſs of weight ſuſtained by the ſolid. This can be done with great eaſe and exactneſs. Whatever may be the bulk of the body, this loſs of weight is the weight of an equal bulk of the fluid ; and we obtain the ſpecific gravity of the body by ſimply dividing its whole weight by the weight loſt : the quotient is the ſpecific gravity when this fluid is taken for the ſtandard, even though we ſhould not know the abſolute weight of any given bulk of this ſtandard. It alſo gives us an eaſy and accurate method of aſcertaining even this fundamental point. We have only to form any ſolid body into an exact cube, ſphere, or priſm, of known dimenſions, and obſerve what weight it loſes when immerſed in this ſtandard fluid. This is the weight of the ſame bulk of the ſtandard to be kept in remembrance ; and thus we obtain, by the bye, a moſt eaſy and accurate method for meaſuring the bulk or ſolid contents of any body, however irregular its ſhape may be. We have only to ſee how much weight it loſes in the ſtandard fluid ; we can compute what quantity of the ſtandard fluid will have this weight. Thus ſhould we find that a quantity of ſand, or a furze buſh, loſes 250 ounces when immerſed in pure water, we learn by this that the ſolid meaſure of every grain of the ſand, or of every twig and prickle of the furze, when added into one ſum, amounts to the fourth part of a cubic foot, or to 432 cubic inches.

To all theſe advantages of the Archimedean method of aſcertaining the ſpecific gravity of bodies, derived from his hydroſtatical doctrines and diſcoveries, we may add, that the immediate ſtandard of compariſon, namely, water, is, of all the ſubſtances that we know, the fitteſt for the purpoſe of an univerſal ſtandard of reference. In its ordinary natural ſtate it is ſufficiently conſtant and uniform in its weight for every examination where the utmoſt mathematical accuracy is not wanted ; all its variations ariſe from impurities, from which it may at all times be ſeparated by the ſimple proceſs of diſtillation : and we have every reaſon to think that when pure, its denſity, when of the ſame temperature, is invariable.

Water is therefore univerſally taken for the unit of that ſcale on which we meaſure the ſpecific gravity of bodies, and its weight is called 1. The ſpecific gravity of any other body is the real weight in pounds and ounces, when of the bulk of one pound or one ounce of water. It is therefore of the firſt importance, in all diſcuſſions reſpecting the ſpecific gravity of bodies, to have the preciſe weight of ſome known bulk of pure water. We have taken ſome pains to examine and compare the experiments on this ſubject, and ſhall endeavour to aſcertain this point with the preciſion which it deſerves. We ſhall reduce all to the Engliſh cubic foot and avoirdupois ounce of the Exchequer ſtandard, on account of a very convenient circumſtance peculiar to this unit, viz. that a cubic foot contains almoſt preciſely a thouſand ounces of pure water, ſo that the ſpecific gravity of bodies expreſſes the number of ſuch ounces contained in a cubic foot.

We begin with a trial made before the houſe of commons in 1696 by Mr Everard. He weighed 2145.6 cubic inches of water by a balance, which turned ſenſibly with 6 grains, when there were 30 pounds in each ſcale. The weights employed were the troy weights, in the depoſit of the Court of Exchequer, which are ſtill preſerved, and have been moſt ſcrupulouſly examined and compared with each other. The weight was 1131 ounces 14 pennyweights. This wants juſt 11 grains of a thouſand avoirdupois ounces for 1728 cubic inches, or a cubic foot ; and it would have amounted to that weight had it been a degree or two colder. The temperature indeed is not mentioned ; but as the trial was made in a comfortable room, we may preſume the temperature to have been about 55° of Fahrenheit's thermometer. The dimenſions of the veſſel were as accurate as the nice hand of Mr Abraham Sharp, Mr Flamſtead's aſſiſtant at Greenwich, could execute, and it was made by the Exchequer ſtandard of length.

This is confided in by the naturaliſts of Europe as a very accurate ſtandard experiment, and it is confirmed by many others both private and public. The ſtandards of weight and capacity employed in the experiment are ſtill in exiſtence, and publicly known, by the report of the Royal Society to parliament in 1742, and by the report of a committee of the houſe of commons in 1758. This gives it a ſuperiority over all the meaſures which have come to our knowledge.

The firſt experiment, made with proper attention, that we meet with, is by the celebrated Snellius, about the year 1615, and related in his *Eratoſthenes Batavus*. He weighed a Rhinland cubic foot of diſtilled water, and found it 62.79 Amſterdam pounds. If this was the ordinary weight of the ſhops, containing 7626 Engliſh troy grains, the Engliſh cubic foot muſt be 62 pounds 9 ounces, only one ounce more than by Everard's experiment. If it was the Mint pound, the weight was 62 pounds 6 ounces. The only other trials which can come into competition with Mr Everard's are ſome made by the Academy of Sciences at Paris. Picart, in 1691, found the Paris cubic foot of the water of the fountain d'Arcueil to weigh 69.588 pounds, *poids de Paris*. Du Hamel obtained the very ſame reſult ; but Mr Monge, in 1783, ſays that filtered rain-water of the temperature 12° (Reaumur) weighs 69.3792. Both theſe meaſures are conſiderably below Mr Everard's, which is 62.5, the former giving 62.053, and the latter 61.868. M. Lavoiſier ſtates the Paris cubic foot at 70 pounds, which makes the Engliſh foot 62.47. But there is an inconſiſtency

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fiftency among them which makes the comparifon impoffible. Some changes were made in 1688, by royal authority, in the national ftandards, both of weight and length; and the academicians are exceedingly puzzled to this day in reconciling the differences, and cannot even afcertain with perfect affurance the lineal meafures which were employed in their moft boafted geodetical operations.

Such variations in the meafurements made by perfons of reputation for judgement and accuracy engaged the writer of this article fome years ago to attempt another. A veffel was made of a cylindrical form, as being more eafily executed with accuracy, whofe height and diameter were 6 inches, taken from a moft accurate copy of the Exchequer ftandard. It was weighed in diftilled water of the temperature 55° feveral times without varying 2 grains, and it loft 42895 grains. This gives for the cubic foot 998.74 ounces, deficient from Mr Everard's an ounce and a quarter; a difference which may be expected, fince Mr Everard ufed the New River water without diftillation.

We hope that thefe obfervations will not be thought fuperfluous in a matter of fuch continual reference, in the moft interefting queftions both to the philofopher and the man of bufinefs; and that the determination which we have given will be confidered as fufficiently authenticated.

Let us, therefore, for the future take water for the ftandard, and fuppofe that, when of the ordinary temperature of fummer, and in its ftate of greateft natural purity, viz. in clean rain or fnow, an Englifh cubic foot of it weighs a thoufand avoirdupois ounces of 437.5 troy grains each. Divide the weight of any body by the weight of an equal bulk of water, the quotient is the fpecific gravity of that body; and if the three firft figures of the decimal be accounted integers, the quotient is the number of avoirdupois ounces in a cubic foot of the body. Thus the fpecific gravity of the very fineft gold which the refiner can produce is 19.365, and a cubic foot of it weighs 19365 ounces.

But an important remark muft be made here. All bodies of homogeneous or unorganifed texture expand by heat, and contract by cooling. The expanfion and contraction by the fame change of temperature is very different in different bodies. Thus water, when heated from 60° to 100°, increafes its volume nearly $\frac{1}{167}$ of its bulk, and mercury only $\frac{1}{241}$, and many fubftances much lefs. Hence it follows, that an experiment determines the fpecific gravity only in that very temperature in which the bodies are examined. It will therefore be proper always to note this temperature; and it will be convenient to adopt fome very ufeful temperature for fuch trials in general: perhaps about 60° of Fahrenheit's thermometer is as convenient as any. It may always be procured in thefe climates without inconvenience. A temperature near to freezing would have fome advantages, becaufe water changes its bulk very little between the temperature 32° and 45°. But this temperature cannot always be obtained. It will much conduce to the facility of the comparifon to know the variation which heat produces on pure water. The following table, taken from the obfervations of Dr Blagden and Mr Gilpin (Phil. Tranf. 1792) will anfwer this purpofe.

Temperature of Water.	Bulk of Water.	Specific Gravity.
30		
35	99910	1.00090
40	99070	1.00094
45	99914	1.00086
50	99932	1.00068
55	99962	1.00038
60	100000	1.00000
65	100050	0.99950
70	100106	0.99894
75	100171	0.99830
80	100242	0.99759
85	100320	0.99681
90	100404	0.99598
95	100501	0.99502
100	100602	0.99402

Thofe gentlemen obferved the expanfion of water to be very anomalous between 32° and 45°. This is diftinctly feen during the gradual cooling of water to the point of freezing. It contracts for a while, and then fuddenly expands. But we feldom have occafion to meafure fpecific gravities in fuch temperature.

The reader is now fufficiently acquainted with the principles of this hydroftatical method of determining the fpecific gravity of bodies, and can judge of the propriety of the forms which may be propofed for the experiment.

The fpecific gravity of a fluid may be determined either by filling with it a veffel with a narrow neck, or by weighing a folid body that is immerfed in it. It is hard to fay which is the beft way. The laft is not fubject to any error in filling, becaufe we may fufpend the folid by a fine wire, which will not difplace any fenfible quantity of the fluid; and if the folid is but a little heavier than the fluid, the balance being loaded only with the excefs, will be very fenfible to the fmalleft want of equilibrium. But this advantage is perhaps compenfated by an obftruction to the motion of the folid up or down in the fluid, arifing from vifcidity. When the weight in the oppofite fcale is yet too fmall, we flowly add more, and at laft grain by grain, which gradually brings the beam to the level. When it is exactly level, the weight in the fcale is fomewhat too great; for it not only balances the preponderance of the folid, but alfo this vifcidity of the fluid. But we may get rid of this error. Add a fmall quantity more; this will bring the beam over to the other fide. Now put as much into the fcale on the fame fide with the folid; this will not reftore the beam to its level. We muft add more till this be accomplifhed; and this addition is the meafure of the vifcidity of the fluid, and muft be fubtracted from the weight that was in the other fcale when the beam came *firft* to a level. This effect of vifcidity is not infenfible, with nice apparatus, even in the pureft water, and in many fluids it is very confiderable—and, what is worfe, it is very changeable. It is greatly diminifhed by heat; and this is an additional reafon for making

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making those trials in pretty warm temperatures. But for fluids of which the viscidity is considerable, this method is by no means proper; and we must take the other, and weigh them in a vessel with a narrow neck. Mercury must also be treated in this way, because we have no solid that will sink in it but gold and platina.

It is not so easy as one would imagine to fill a vessel precisely to the same degree upon every trial. But if we do not operate on too small quantities, the unavoidable error may be made altogether insignificant, by having the neck of the vessel very small. If the vessel hold a pound of water, and the neck do not exceed a quarter of an inch (and it will not greatly retard the operation to have it half this size), the examinator must be very careless indeed to err one part in two thousand; and this is perhaps as near as we can come with a balance. We must always recollect that the capacity of the vessel changes by heat, and we must know this variation, and take it into the account. But it is affectation to regard (as Mr Homberg would make us believe that he did) the distension of the vessel by the pressure of the fluid. His experiments of this kind have by no means the consistency with each other that should convince us that he did not commit much greater errors than what arose from distension.

In examining either solids or fluids, we must be careful to free their surface, or that of the vessel in which the fluid is to be weighed, from air, which frequently adheres to it in a peculiar manner, and, by forming a bubble, increases the apparent bulk of the solid, or diminishes the capacity of the vessel. The greatest part of what appears on those occasions seems to have existed in the fluid in a state of chemical union, and to be set at liberty by the superior attraction of the fluid for the contiguous solid body. These air bubbles must be carefully brushed off by hand. All greasy matters must be cleared off for the same reason: they prevent the fluid from coming into contact.

We must be no less careful that no water is imbibed by the solid, which would increase its weight without increasing its bulk. In some cases, however, a very long maceration and imbibition is necessary. Thus, in examining the specific gravity of the fibrous part of vegetables, we should err exceedingly if we imagined it as small as appears at first. We believe that in most plants it is at least as great as water, for after long maceration they sink in it.

It is almost needless to say that the nicest and most sensible balances are necessary for this examination. Balances are even constructed on purpose, and fitted with several pieces of apparatus, which make the examination easy and neat. We have described (see BALANCE) Mr Gravesande's as one of the most convenient of any. His contrivance for observing the fractions of a grain is extremely ingenious and expeditious, especially for detecting the effect of viscidity.

The hydrometer, or areometer, is another instrument for ascertaining the specific gravity of fluids. This very pretty instrument is the invention of a lady, as eminent for intellectual accomplishments as she was admired for her beauty. Hypatia, the learned daughter of the celebrated mathematician Theon of Alexandria, became so eminent for her mathematical knowledge, that she was made public professor of the science in the first school in the world. She wrote a commentary on the works of Apollonius and of Diophantus, and composed Astronomical Tables; all of which are lost. These rare accomplishments, however, could not save her from the fury of the fanatics of Alexandria, who cut her in pieces for having taken an offensive part in a dispute between the governor and patriarch.—We have described some of the most approved of these instruments in the article HYDROMETER, and shall in this place make a few observations on the principles of their construction, not as they are usually made, accommodated to the examination of particular liquors, but as indicators of pure specific gravity. And we must premise, that this would, for many reasons, be the best way of constructing them. The very ingenious contrivances for accommodating them to particular purposes are unavoidably attended with many sources of error, both in their adjustment by the maker and in their use; and all that is gained by a very expensive instrument is the saving the trouble of inspecting a table. A simple scale of specific gravity would expose to no error in construction, because all the weights but one, or all the points of the scale but one, are to be obtained by calculation, which is incomparably more exact than any manual operation, and the table can always be more exact than any complex observation. But a still greater advantage is, that the instruments would by this means be fitted for examining all liquors whatever, whereas at present they are almost useless for any but the one for which they are constructed.

Hydrometers are of two kinds. The most simple and the most delicate are just a substitute for the hydrostatical balance. They consist of a ball (or rather an egg or pear-shaped vessel, which moves more easily through the fluid) A (fig. 1.) having a foot projecting down from it, terminated by another ball B, and a slender stalk or wire above, carrying a little dish C. The whole is made so light as to float in the lightest fluid we are acquainted with; such as vitriolic or muriatic ether, whose specific gravity is only 0.73. This number should be marked on the dish, indicating that this is the specific gravity of the fluid in which the instrument floats, sinking to the point D of the stem. The ball B is made heavy, and the foot is of some length, that the instrument may have stability, and swim erect, even if considerably loaded above; and, for the same reason, it must be made very round, otherwise it will lean to a side. When put into a heavier liquor, its buoyancy will cause it to float with a part of the ball above the surface. Weights are now put into the scale C, till the instrument sink to D. The weight put into the scale, added to the weight of the instrument, is the weight of the displaced fluid. This, compared with the weight of the whole when the instrument is swimming in pure water, gives the specific gravity of the fluid. All trouble of calculation may be avoided by marking the weights with such numbers as shall indicate the specific gravity at once. Thus having loaded the instrument so as to sink it to D in pure water, call the whole weight 1000; then weigh the instrument itself, and say, "as the weight when swimming in water is to its present weight, so is 1000 to a 4th proportional." This is the specific gravity of the liquor which would float the unloaded instrument. Suppose this to be 730. The hydrometer would just float in muriatic ether, and this should be marked on the side. Now make a set of small weights,

weights, and mark them, not by their weights in grains, but in fuch units that 270 of them fhall be equal to the weight which fits the inftrument for pure water.

Suppofe that, in order to float this inftrument in a certain brandy, there are required 186 in thefe fmall weights. This added to 730 gives 916 for the fpecific gravity, and fhows it to be precifely excife proof fpirit. Nine weights, viz. 256, 128, 64, 32, 16, 8, 4, 2, 1, will fuffice for all liquors from ether to the ftrongeft worts. And that the trouble in changing the weights may be greatly leffened, let a few circles a, b, c, d, e, be marked on the top of the ball. When we fee it float unloaded at the circle C for inftance, we know it will require at leaft 128 to fink it to D on the ftem.

If the weights to be added above are confiderable, it raifes the centre of gravity fo much, that a fmall want of equilibrium, by laying the weights on one fide, will produce a great inclination of the inftrument, which is unfightly. Inftead therefore of making them loofe weights, it is proper to make them round plates, with a fmall hole in the middle, to go on a pin in the middle of the fcale. This will keep the inftrument always upright. But unlefs the hydrometer is of a confiderable fize, it can hardly be made fo as to extend from the lighteft to the heavieft fluid which we may have occafion to examine, even though we except mercury. Some of the mineral acids are confiderably more than twice the weight of ether. When there is fuch a load at top, the hydrometer is very apt to overfet, and inclines with the fmalleft want of equilibrium. Great fize is inconvenient even to the philofopher, becaufe it is not always in his power to operate on a quantity of fluid fufficient to float the inftrument. Therefore two, or perhaps three, are neceffary for general examination. One may reach from ether to water; another may ferve for all liquors of a fpecific gravity between one and one and a half; and the third, for the mineral acids, may reach from this to two. If each of thefe be about two folid inches in capacity, we may eafily and expeditioufly determine the fpecific gravity within one ten thoufandth part of the truth: and this is precifion enough for moft purpofes of fcience or bufinefs.

The chief queftions are, 1. To afcertain the fpecific gravity of an unknown fluid. This needs no farther explanation. 2. To afcertain the proportion of two fluids which are known to be in a mixture. This is done by difcovering the fpecific gravity of the mixture by means of the hydrometer, and then deducing the proportion from a comparifon of this with the fpecific gravities of the ingredients.

In this mode of examination the bulk is always the fame; for the hydrometer is immerged in the different fluids to the fame depth. Now if an inch, for example, of this bulk is made up of the heavieft fluid, there is an inch wanting of the lighteft; and the change made in the weight of the mixture is the difference between the weight of an inch of the heavieft, and of an inch of the lighteft ingredients. The number of inches therefore of the heavieft fluid is proportional to the addition made to the weight of the mixture. Therefore let B and b be the bulks of the heavieft and lighteft fluids in the bulk β of the mixture; and let D, d, and δ be the denfities, or the weights, or the fpecific gravities (for they are in one ratio) of the heavy fluid, the light fluid, and the mixture (their bulk being that of the hydrometer). We have $\beta = B + b$. The addition which would have been made to the bulk β, if the lighteft fluid were changed entirely for the heavieft, would be $D - d$; and the change which is really made is $\delta - d$. Therefore $\beta : b = D - d : \delta - d$. For fimilar reafons we fhould have $\beta : B = D - d : D - \delta$; or, in words, "*the difference between the fpecific gravities of the two fluids, is to the difference between the fpecific gravities of the mixture and of the lighteft fluid, as the bulk of the whole to the bulk of the heavieft contained in the mixture;*" and "*the difference of the fpecific gravities of the two fluids, is to the difference of the fpecific gravities of the mixture and of the heavieft fluids, as the bulk of the whole to that of the lighteft contained in the mixture.*" This is the form in which the ordinary bufinefs of life requires the anfwer to be expreffed, becaufe we generally reckon the quantity of liquors by bulk, in gallons, pints, quarts. But it would have been equally eafy to have obtained the anfwer in pounds and ounces; or it may be had from their bulk, fince we know their fpecific gravities.

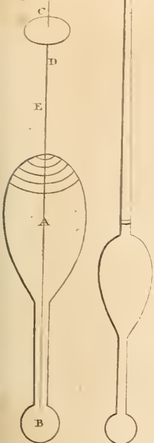
The hydrometer more commonly ufed is the ancient one of Hypatia, confifting of a ball A (fig. 2.) made fteady by an addition B, below it like the former, but having a long ftem CF above. It is fo loaded that it finks to the top F of the ftem in the lighteft of all the fluids which we propofe to meafure with it, and to fink only to C in the heavieft. In a fluid of intermediate fpecific gravity it will fink to fome point between C and F.

In this form of the hydrometer the weight is always the fame, and the immediate information given by the inftrument is that of different bulks with equal weight. Becaufe the inftrument finks till the bulk of the difplaced fluid equals it in weight, and the additions to the difplaced fluid are all made by the ftem, it is evident that equal bulks of the ftem indicate equal additions of volume. Thus the ftem becomes a fcale of bulks to the fame weight.

The only form in which the ftem can be made with fufficient accuracy is cylindrical or prifmatical. Such a ftem may be made in the moft accurate manner by wiredrawing, that is, paffing it through a hole made in a hardened fteel plate. If fuch a ftem be divided into equal parts, it becomes a fcale of bulks in arithmetical progreffion. This is the eafieft and moft natural divifion of the fcale; but it will not indicate denfities, fpecific gravities, or weights of the fame bulk in arithmetical progreffion. The fpecific gravity is as the weight divided by the bulk. Now a feries of divifors (the bulks), in arithmetical progreffion, applied to the fame dividend (the bulk and weight of the hydrometer as it floats in water), will not give a feries of quotients (the fpecific gravities) in arithmetical progreffion: they will be in what is called *harmonic progreffion*, their differences continually diminifhing. This will appear even when phyfically confidered. When the hydrometer finks a tenth of an inch near the top of the ftem, it difplaces one tenth of an inch of a light fluid, compared with that difplaced by it when it is floating with all the ftem above the furface. In order therefore that the divifions of the ftem may indicate equal changes of fpecific gravity, they muft be in a feries of harmonic progreffionals increafing. The point at which the inftrument floats in pure water fhould be marked 1000, and thofe above it 999, 998, 997, &c.; and thofe

SPECIFIC Gravity

Fig. 1. *Fig. 2.*



SPINNING Machinery. Plate CCCCXCIX.

Fig. 1.

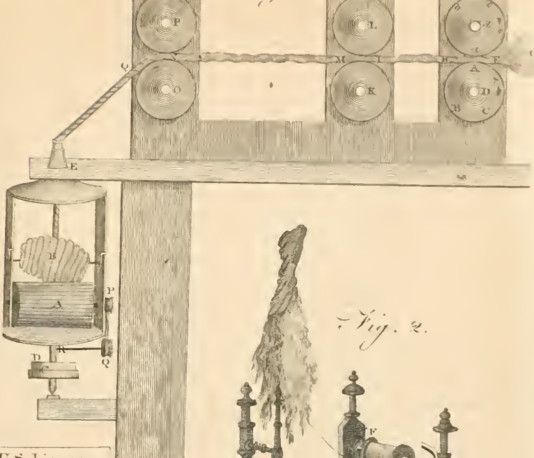
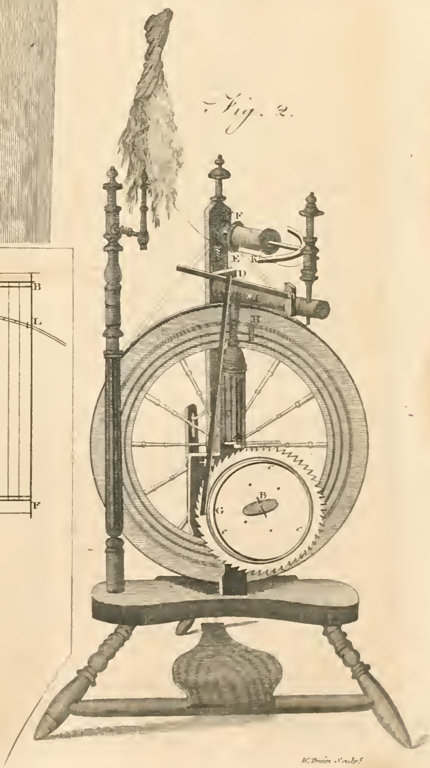


Fig. 2.



SPIRITUOUS Liquors.

Fig. 1.

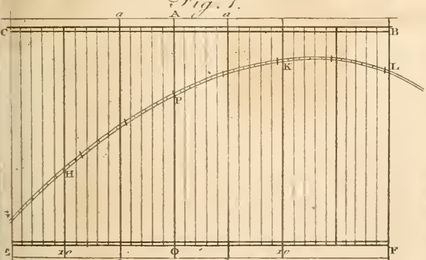
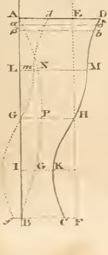


Fig. 2.



W. Prain Sculp.

thoſe below the water mark muſt be numbered 1001, 1002, 1003, &c. Such a ſcale will be a very appoſite picture of the denſities of fluids, for the denſity or vicinity of the diviſions will be preciſely ſimilar to the denſity of the fluids. Each interval is a bulk of fluid of the ſame weight. If the whole inſtrument were drawn out into wire of the ſize of the ſtem, the length from the water mark would be 1000.

Such are the rules by which the ſcale muſt be divided. But there muſt be ſome points of it determined by experiment, and it will be proper to take them as remote from each other as poſſible. For this purpoſe let the inſtrument be accurately marked at the point where it ſtands, in two fluids, differing as much in ſpecific gravity as the inſtrument will admit. Let it alſo be marked where it ſtands in water. Then determine with the utmoſt preciſion the ſpecific gravities of theſe fluids, and put their values at the correſponding points of the ſcale. Then the intermediate points of the ſcale muſt be computed for the different intervening ſpecific gravities, or it muſt be divided from a pattern ſcale of harmonic progreſſionals in a way well known to the mathematical inſtrument-makers. If the ſpecific gravities have been accurately determined, the value 1000 will be found to fall preciſely in the water mark. If we attempt the diviſion entirely by experiment, by making a number of fluids of different ſpecific gravities, and marking the ſtem as it ſtands in them, we ſhall find the diviſions turn out very anomalous. This is however the way uſually practiſed; and there are few hydrometers, even from the beſt maker, that hold true to a ſingle diviſion or two. Yet the method by computation is not more troubleſome; and one ſcale of harmonic progreſſionals will ſerve to divide every ſtem that offers. We may make uſe of a ſcale of equal parts for the ſtem, with the aſſiſtance of two little tables. One of theſe contains the ſpecific gravities in harmonic progreſſion, correſponding to the arithmetical ſcale of bulks on the ſtem of the hydrometer; the other contains the diviſions and fractions of a diviſion of the ſcale of bulks, which correſpond to an arithmetical ſcale of ſpecific gravities. We believe this to be the beſt method of all. The ſcale of equal parts on the ſtem is ſo eaſily made, and the little table is ſo eaſily inſpected, that it has every advantage of accuracy and diſpatch, and it gives, by the way, an amuſing view of the relation of the bulks and denſities.

We have hitherto ſuppoſed a ſcale extending from the lighteſt to the heavieſt fluid. But unleſs it be of a very inconvenient length, the diviſions muſt be very minute. Moreover, when the bulk of the ſtem bears a great proportion to that of the body, the inſtrument does not ſwim ſteady; it is therefore proper to limit the range of the inſtrument in the ſame manner as thoſe of the firſt kind. A range from the denſity of ether to that of water may be very well executed in an inſtrument of very moderate ſize, and two others will do for all the heavier liquors; or an equal range in any other denſities as may ſuit the uſual occupations of the experimenter.

To avoid the inconveniences of a hydrometer with a very long and ſlender ſtem, or the neceſſity of having a ſeries of them, a third ſort has been contrived, in which the principles of both are combined. Suppoſe a hydrometer with a ſtem, whoſe bulk is $\frac{1}{10}$th of that of the ball, and that it ſinks in ether to the top of the ſtem; it is evident that in a fluid which is $\frac{1}{10}$th heavier, the whole ſtem will emerge; for the bulk of the diſplaced fluid is now $\frac{1}{10}$th of the whole leſs, and the weight is the ſame as before, and therefore the ſpecific gravity is $\frac{1}{10}$th greater.

Thus we have obtained a hydrometer which will indicate, by means of diviſions marked on the ſtem, all ſpecific gravities from 0.73 to 0.803; for 0.803 is $\frac{1}{10}$th greater than 0.73. Theſe diviſions muſt be made in harmonic progreſſion, as before directed for an entire ſcale, placing 0.73 at the top of the ſtem and 0.803 at the bottom.

When it floats at the loweſt diviſion, a weight may be put on the top of the ſtem, which will again ſink it to the top. This weight muſt evidently be 0.073, or $\frac{1}{10}$th of the weight of the fluid diſplaced by the unloaded inſtrument. The hydrometer, thus loaded, indicates the ſame ſpecific gravity, by the top of the ſtem, that the unloaded inſtrument indicates by the loweſt diviſion. Therefore, when loaded, it will indicate another ſeries of ſpecific gravities, from 0.803 to 0.8833 (= 0.803 + 0.0803), and will float in a liquor of the ſpecific gravity 0.8833 with the whole ſtem above the ſurface.

In like manner, if we take off this weight, and put on 1 = 0.0803, it will ſink the hydrometer to the top of the ſtem; and with this new weight it will indicate another ſeries of ſpecific gravities from 0.8833 to 0.97163 (= 0.8833 + 0.08833). And, in the ſame manner, a third weight = 08833 will again ſink it to the top of the ſtem, and fit it for another ſeries of ſpecific gravities up to 1.068793. And thus, with three weights, we have procured a hydrometer fitted for all liquors from ether to a wort for a malt liquor of two barrels per quarter. Another weight, in the ſame progreſſion, will extend the inſtrument to the ſtrongeſt wort that is brewed.

This is a very commodious form of the inſtrument, and is now in very general uſe for examining ſpirituous liquors, worts, ales, brines, and many ſuch articles of commerce. But the diviſions of the ſcale are generally adapted to the queſtions which naturally occur in the buſineſs. Thus, in the commerce of ſtrong liquors, it is uſual to eſtimate the article by the quantity of ſpirit of a certain ſtrength which the liquor contains.—This we have been accuſtomed to call proof ſpirit, and it is ſuch that a wine gallon weighs 7 pounds 12 ounces, and it is by this ſtrength that the exciſe duties are levied. Therefore the diviſions on the ſcale, and the weights which connect the ſucceſſive repetitions of the ſcale, are made to expreſs at once the number of gallons or parts of a gallon of proof ſpirits contained in a gallon of the liquor. Such inſtruments ſave all trouble of calculation to the exciſeman or dealer; but they limit the uſe of a very delicate and expenſive inſtrument to a very narrow employment. It would be much better to adhere to the expreſſion either of ſpecific gravity or of bulk; and then a very ſmall table, which could be compriſed in the ſmalleſt caſe for the inſtrument, might render it applicable to every kind of fluid.

The reader cannot but have obſerved that the ſucceſſive weights, by which the ſhort ſcale of the inſtrument is extended to a great range of ſpecific gravities, do not increaſe by equal quantities. Each difference is the weight of the liquor diſplaced by the graduated ſtem of the inſtrument when it is ſunk to the top of the

the ſcale. It is a determined aliquot part of the whole weight of the inſtrument ſo loaded, (in our example it is always $\frac{1}{11}$th of it). It increaſes therefore in the ſame proportion with the preceding weight of the loaded inſtrument. In ſhort, both the ſucceſſive additions, and the whole weights of the loaded inſtrument, are quantities in geometrical progreſſion; and, in like manner, the diviſions on the ſcale, if they correſpond to equal differences of ſpecific gravity, muſt alſo be unequal—This is not ſufficiently attended to by the makers; and they commit an error here, which is very conſiderable when the whole range of the inſtrument is great. For the value of one diviſion of the ſcale, when the largeſt weight is on, is as much greater than its value, when the inſtrument is not loaded at all, as the full loaded inſtrument is heavier than the inſtrument unloaded. No manner whatever of dividing the ſcale will correſpond to equal differences of ſpecific gravity through the whole range with different weights; but if the diviſions are made to indicate equal *proportions* of gravity when the inſtrument is uſed without a weight, they will indicate equal *proportions* throughout. This is evident from what we have been juſt now ſaying; for the proportion of the ſpecific gravities correſponding to any two immediately ſucceeding weights is always the ſame.

The beſt way, therefore, of conſtructing the inſtrument, ſo that the ſame diviſions of the ſcale may be accurate in all its ſucceſſive repetitions with the different weights, is to make theſe diviſions in geometrical progreſſion. The correſponding ſpecific gravities will alſo be in geometric proportion. Theſe being all inſerted in a table, we obtain them with no more trouble than by inſpecting the ſcale which uſually accompanies the hydrometer. This table is of the moſt eaſy conſtruction; for the ratio of the ſucceſſive bulks and ſpecific gravities being all equal, the differences of the logarithms are equal.

This will be illuſtrated by applying it to the example already given of a hydrometer extending from 0.73 to 1.068793 with three weights. This gives four repetitions of the ſcale on the ſtem. Suppoſe this ſcale divided into 10 parts, we have 40 ſpecific gravities.—Let theſe be indicated by the numbers 0, 1, 2, 3, &c. to 40. The mark 0 is affixed to the top of the ſtem, and the diviſions downwards are marked 1, 2, 3, &c. the loweſt being 10. Theſe diviſions are eaſily determined. The ſtem, which we may ſuppoſe 5 inches long, was ſuppoſed to be $\frac{1}{10}$th of the capacity of the ball. It may therefore be conſidered as the extremity of a rod of 11 times its length, or 55 inches; and we muſt find nine mean proportionals between 50 and 55 inches. Subtract each of theſe from 55 inches, and the remainders are the diſtances of the points of diviſion from 0, the top of the ſcale. The ſmalleſt weight is marked 10, the next 20, and the third 30. If the inſtrument loaded with the weight 20 ſinks in ſome liquor to the mark 7, it indicates the ſpecific gravity 27, that is, the 27th of 40 mean proportionals between 0.73 and 1.068793, or 0.944242. To obtain all theſe intermediate ſpecific gravities, we have only to ſubtract 9.8633229, the logarithm of 0.73, from that of 1.068793, viz. 0.0288937, and take 0.0041393, the 40th part of the difference. Multiply this by 1, 2, 3, &c. and add the logarithm of 0.73 to each of the products. The ſums are the logarithms of the ſpecific gravities required. Theſe will be found to proceed ſo equably, that they may be interpolated ten times by a ſimple table of proportional parts without the ſmalleſt ſenſible error. Therefore the ſtem may be divided into a hundred parts very ſenſible to the eye (each being nearly the 20th of an inch), and 406 degrees of ſpecific gravity obtained within the range, which is as near as we can examine this matter by any hydrometer. Thus the ſpecific gravities correſponding to N° 26, 27, 28, 29, are as follow:

		1ſt Diff.	2d Diff.
26	0.93529		
27	0.94424	895	
28	0.95328	904	9
29	0.96241	913	9

Nay, the trouble of inſpecting a table may be avoided, by forming on a ſcale the logarithms of the numbers between 7300 and 1068.793, and placing along ſide of it a ſcale of the ſame length divided into 400 equal parts, numbered from 0 to 400. Then, looking for the mark ſhown by the hydrometer on this ſcale of equal parts, we ſee oppoſite to it the ſpecific gravity.

We have been thus particular in the illuſtration of this mode of conſtruction, becauſe it is really a beautiful and commodious inſtrument, which may be of great uſe both to the naturaliſt and to the man of buſineſs.—A table may be compriſed in 20 octavo pages, which will contain the ſpecific gravities of every fluid which can intereſt either, and anſwer every queſtion relative to their admixture with as much preciſion as the obſervations can be made. We therefore recommend it to our readers, and we recommend the very example which we have given as one of the moſt convenient. The inſtrument need not exceed eight inches in length, and may be contained in a pocket caſe of two inches broad and as many deep, which will alſo contain the ſcale, a thermometer, and even the table for applying it to all fluids which have been examined.

It is unfortunate that no graduated hydrometer can be made ſo eaſily for the examination of the corroſive mineral acids (A). Theſe muſt be made of glaſs, and we cannot depend on the accurate cylindric form of any glaſs ſtem. But if any ſuch can be procured, the conſtruction is the ſame. The divided ſcale may either be on thin paper paſted on the inſide of the ſtem, or it may be printed on the ſtem itſelf from a plate, with ink made of a metallic calx, which will attach itſelf to the glaſs with a very moderate heat. We would recommend common white enamel, or arſenical glaſs, as the fitteſt material for the whole inſtrument; and the ink uſed, in taking the impreſſion of the ſcale, may be the ſame that is uſed for the low-priced printing on Delft ware pottery.—Firſt form the ſcale on the ſtem. Then, having meaſured the ſolid contents of the graduated part as exactly as poſſible, and determined on the general ſhape of

(A) It would be worth while to try copper enamelled.

of the ball and counterpoife below, calculate its fize, fo that it may be a little lefs than ten times that of the ftem. The glafs-blower can copy this very nearly, and join it to the ftem. Then make two brines or other liquors, which fhall have fpecific gravities in the ratio of 10 to 11. Load the inftrument fo that it may fink to 0 in the lighteft. When put into the heavieft, it fhould rife to 10. If it does not rife fo high, the immerfed part is too fmall. Let the glafs-blower enlarge the ball of the counterpoife a little. Repeat this trial till it be exact. Nothing now remains but to form the weights: And here we obferve, that when the inftrument is to have a very great range, as for examining all ftates of the vitriolic acid, it has a chance of being very tottering when loaded with the greateft weight on the top of fo long a fcale. To avoid this, Mr Quin and others have added fome of their weights below.—But this will not fuit the prefent conftruction, becaufe it will alter the proportion between the bulks of the ftem and immerfed part. Therefore let thefe weights confift of cylinders of metal fmall enough to go into the ftem, and let them be foldered to the end of long wires, which will let them go to the bottom, and leave a fmall hook or ring at top. Thefe can lie alongfide of the inftrument in its cafe. This is indeed the beft conftruction for every hydrometer, becaufe it makes it incomparably more fteady. The inftrument is poifed by fmall fhot or mercury. But it will be much better to do it with Newton's fufible metal (three parts of tin, five parts of lead, and eight parts of bifmuth) in coarfe filings. When the exact quantity has been put in, the inftrument may be fet in a veffel of oil, and this kept on the fire till all is completely melted. It foon freezes again, and remains faft. If this metal is not to be had, let a few bits of fealing-wax be added to the mercury or fhot, to make up the counterpoife. When heated, it will float a-top, and when it freezes again it will keep all faft. Thus we fhall make a very complete and cheap inftrument.

There is yet another method of examining the fpecific gravities of fluids, firft propofed by Dr Wilfon, late profeffor of aftronomy in the univerfity of Glafgow. This is by a feries of fmall glafs bubbles, differing equally, or according to fome rule, from each other in fpecific gravity, and each marked with its proper number. When thefe are thrown into a fluid which is to be examined, all thofe which are heavier than the fluid will fall to the bottom. Then holding the veffel in the hand, or near a fire or candle, the fluid expands, and one of the floating bubbles begins to fink. Its fpecific gravity, therefore was either equal to, or a little lefs than, that of the fluid; and the degree of the thermometer, when it began to fink, will inform us how much it was deficient, if we know the law of expanfion of the liquor. Sets of thefe bubbles fitted for the examination of fpirituous liquors, with a little treatife fhowing the manner of ufing them, and calculating by the thermometer, are made by Mr Brown, an ingenious artift of Glafgow, and are often ufed by the dealers in fpirits, being found both accurate and expeditious.

Alfo, though a bubble or two fhould be broken, the ftrength of fpirits may eafily be had by means of the remainder, unlefs two or three in immediate fucceffion be wanting: for a liquor which anfwers to N° 4 will fink N° 2. by heating it a few degrees, and therefore N° 3. may be fpared. This is a great advantage in ordinary bufinefs. A nice hydrometer is not only an expenfive inftrument, but exceedingly delicate, being fo very thin. If broken or even bruifed, it is ufelefs, and can hardly be repaired except by the very maker.

As the only queftion here is, to determine how many gallons of excife proof fpirits is contained in a quantity of liquor, the artift has conftructed this feries of bubbles in the fimpleft manner poffible, by previoufly making 40 or 50 mixtures of fpirits and water, and then adjufting the bubbles to thefe mixtures. In fome fets the number on each bubble is the number of gallons of proof fpirits contained in 100 gallons of the liquor. In other fets the number on each bubble expreffes the gallons of water which will make a liquor of this ftrength, if added to 14 gallons of alcohol. Thus, if a liquor anfwers to N° 4, then 4 gallons of water added to 14 gallons of alcohol will make a liquor of this ftrength. The firft is the beft method; for we fhould be miftaken in fuppofing that 18 gallons, which anfwer to N° 4, contains exactly 14 gallons of alcohol: it contains more than 14, for a reafon to be given by and by.

By examining the fpecific gravity of bodies, the philofopher has made fome very curious difcoveries. The moft remarkable of thefe is the change which the denfity of bodies fuffers by mixture. It is a moft reafonable expectation, that when a cubic foot of one fubftance is mixed *any how* with a cubic foot of another, the bulk of the mixture will be two cubic feet; and that 18 gallons of water joined to 18 gallons of oil will fill a veffel of 36 gallons. Accordingly this was never doubted; and even Archimedes, the moft fcrupulous of mathematicians, proceeded on this fuppofition in the folution of his famous problem, the difcovery of the proportion of filver and gold in a mixture of both. He does not even mention it as a poftulate that *may* be granted him, fo much did he conceive it to be an axiom. Yet a little reflection feems fufficient to make it doubtful and to require examination. A box filled with mufket-balls will receive a confiderable quantity of fmall fhot, and after this a confiderable quantity of fine fand, and after this a confiderable quantity of water. Something like this might happen in the admixture of bodies of porous texture. But fuch fubftances as metals, glafs, and fluids, where no difcontinuity of parts can be perceived, or was fufpected, feem free from every chance of this kind of introfufception. Lord Bacon, however, without being a naturalift or mathematician *ex profeffo*, inferred from the mobility of fluids that they confifted of difcrete particles, which muft have pores interpofed, whatever be their figure. And if we afcribe the different denfities, or other fenfible qualities, to difference in fize or figure of thofe particles, it muft frequently happen that the fmaller particles will be lodged in the interftices between the larger, and thus contribute to the weight of the fenfible mafs without increafing its bulk. He therefore fufpects that mixtures will be in general lefs bulky than the fum of their ingredients.

Accordingly, the examination of this queftion was one of the firft employments of the Royal Society of London, and long before its inftitution had occupied the attention of the gentlemen who afterwards compofed it. The regifter of the Society's early meetings contains many experiments on this fubject, with mixtures of gold and filver, of other metals, and of various fluids,

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fluids, examined by the hydroftatical balance of Mr Boyle. Dr Hooke made a prodigious number, chiefly on articles of commerce, which were unfortunately loft in the fire of London.

It was foon found, however, that Lord Bacon's conjecture had been well founded, and that bodies changed their denfity very fenfibly in many cafes. In general, it was found that bodies which had a ftrong chemical affinity increafed in denfity, and that their admixture was accompanied with heat.

By this difcovery it is manifeft that Archimedes had not folved the problem of detecting the quantity of filver mixed with the gold in King Hiero's crown, and that the phyfical folution of it requires experiments made on all the kinds of matter that are mixed together. We do not find that this has been done to this day, although we may affirm that there are few queftions of more importance. It is a very curious fact in chemiftry, and it would be moft defirable to be able to reduce it to fome general laws: For inftance, to afcertain what is the proportion of two ingredients which produces the greateft change of denfity. This is important in the fcience of phyfics, becaufe it give us confiderable information as to the mode of action of thofe natural powers or forces by which the particles of tangible matter are united. If this introfufception, concentration, compenetration, or by whatever name it be called, were a mere reception of the particles of one fubftance into the interftices of thofe of another, it is evident that the greateft concentration would be obferved when a fmall quantity of the recipiend is mixed with, or diffeminated through, a great quantity of the other. It is thus that a fmall quantity of fine fand will be received into the interftices of a quantity of fmall fhot, and will increafe the weight of the bagful without increafing its bulk. The cafe is nowife different when a piece of freeftone has grown heavier by imbibing or abforbing a quantity of water. If more than a certain quantity of fand has been added to the fmall fhot, it is no longer concealed. In like manner, various quantities of water may combine with a mafs of clay, and increafe its fize and weight alike. All this is very conceivable, occafioning no difficulty.

But this is not the cafe in any of the mixtures we are now confidering. In all thefe, the firft additions of either of the two fubftances produce but an inconfiderable change of general denfity; and it is in general moft remarkable, whether it be condenfation or rarefaction, when the two ingredients are nearly of equal bulks. We can illuftrate even this difference, by reflecting on the imbibition of water by vegetable folids, fuch as timber. Some kinds of wood have their weight much more increafed than their bulks; other kinds of wood are more enlarged in bulk than in weight. The like happens in grains. This is curious, and fhows in the moft unqueftionable manner that the particles of bodies are not in contact, but are kept together by forces which act at a diftance. For this diftance between the centres of the particles is moft evidently fufceptible of variation; and this variation is occafioned by the introduction of another fubftance, which, by acting on the particles by attraction or repulfion, diminifhes or increafes their mutual actions, and makes new diftances neceffary for bringing all things again into equilibrium. We refer the curious reader to the ingenious theory of the abbé Bofcovich for an excellent illuftration of this fubject (*Theor. Phil. Nat.* § de Solutione Chemica).

This queftion is no lefs important to the man of bufinefs. Till we know the condenfation of thofe metals by mixture, we cannot tell the quantity of alloy in gold and filver by means of their fpecific gravity; nor can we tell the quantity of pure alcohol in any fpirituous liquor, or that of the valuable falt in any folution of it. For want of this knowledge, the dealers in gold and filver are obliged to have recourfe to the tedious and difficult teft of the affay, which cannot be made in all places or by all men. It is therefore much to be wifhed, that fome perfons would inftitute a feries of experiments in the moft interefting cafes: for it muft be obferved, that this change of denfity is not always a fmall matter; it is fometimes very confiderable and paradoxical. A remarkable inftance may be given of it in the mixture of brafs and tin for bells, great guns, optical fpeculums, &c. The fpecific gravity of caft brafs is nearly 8.006, and that of tin is nearly 7.363. If two parts of brafs be mixed with one of tin, the fpecific gravity is 8.917; whereas, if each had retained its former bulk, the fp. grav. would have been only $7.793\left(=\frac{2\times 8.006+7.363}{3}\right)$. A mixture of equal parts fhould have the fpecific gravity 7.684; but it is 8.441. A mixture of two parts tin with one part brafs, inftead of being 7.577, is 8.027.

In all thefe cafes there is a great increafe of fpecific gravity, and confequently a great condenfation of parts or contraction of bulk. The firft mixture of eight cubic inches of brafs, for inftance, with four cubic inches of tin, does not produce 12 cubic inches of bell-metal, but only $10\frac{1}{2}$ nearly, having fhrunk $\frac{1}{8}$. It would appear that the diftances of the brafs particles are moft affected, or perhaps it is the brafs that receives the tin into its pores; for we find that the condenfations in thefe mixtures are nearly proportional to the quantities of the brafs in the mixtures. It is remarkable that this mixture with the lighteft of all metals has made a compofition more heavy and denfe than brafs can be made by any hammering.

The moft remarkable inftance occurs in mixing iron with platina. If 10 cubic inches of iron are mixed with $1\frac{1}{4}$ of platina, the bulk of the compound is only $9\frac{1}{2}$ inches. The iron therefore has not fimply received the platina into its pores: its own particles are brought nearer together. There are fimilar refults in the folution of turbith mineral, and of fome other falts, in water. The water, inftead of rifing in the neck of the veffel, when a fmall quantity of the falt has been added to it, finks confiderably, and the two ingredients occupy lefs room than the water did alone.

The fame thing happens in the mixture of water with other fluids and different fluids with each other: But we are not able to trace any general rule that is obferved with abfolute precifion. In moft cafes of fluids the greateft condenfation happens when the bulks of the ingredients are nearly equal. Thus, in the mixture of alcohol and water, we have the greateft condenfation when $16\frac{1}{2}$ ounces of alcohol are mixed with 20 ounces of water, and the condenfation is about $\frac{1}{50}$ of the whole bulk of the ingredients. It is extremely various in different fubftances, and no claffification of them can be made in this refpect.

A differtation has been publifhed on this fubject by Dr

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Dr Hahn of Vienna, intitled *De Efficacia Mixtionis in mutandis Corporum Voluminibus*, in which all the remarkable inſtances of the variation of denſity have been collected. All that we can do (as we have no directing principle) is to record ſuch inſtances as are of chief importance, being articles of commerce.

The firſt that occurs to us is the mixtures of alcohol and water in the compoſition of ſpirituous liquors. This has been conſidered by many with great care. The moſt ſcrupulous examination of this, or perhaps of any mixture, has been lately made by Dr Blagden (now Sir Charles Blagden) of the Royal Society, on the requiſition of the Board of Exciſe. He has publiſhed an account of the examination in the Philoſophical Tranſactions of London in 1791 and 1792. We ſhall give an account of it under the article *SPIRITUOUS Liquors;* and at preſent only ſelect one column, in order to ſhow the condenſation. The alcohol was almoſt the ſtrongeſt that can be produced, and its ſpecific gravity, when of the temperature 60°, was 0.825. The whole mixtures were of the ſame temperature.

Column 1. contains the pounds, ounces, or other meaſures by weight, of alcohol in the mixture. Column 2. contains the pounds or ounces of water. Column 3. is the ſum of the bulks of the ingredients, the bulk of a pound or ounce of water being accounted 1. Column 4. is the obſerved ſpecific gravity of the mixture, taken from Dr Blagden's diſſertation. Column 5. is the ſpecific gravity which would have been obſerved if the ingredients had each retained its own ſpecific gravity. This we calculated by dividing the ſum of the two numbers of the firſt and ſecond columns by the correſponding number of the third. Column 6. is the difference of column 4. and column 5. and exhibits the condenſation.

TABLE.

A.	W.	Volume.	Sp. Grav. obſerved.	Sp. Grav. calculated.	Condenſation.
20	0	24.2424	0.8250	0.8250	00
20	1	25.2424	0.8360	0.8320	40
20	2	26.2424	0.8457	0.8383	74
20	3	27.2424	0.8543	0.8443	100
20	4	28.2424	0.8621	0.8498	123
20	5	29.2424	0.8692	0.8549	143
20	6	30.2424	0.8757	0.8597	160
20	7	31.2424	0.8817	0.8642	175
20	8	32.2424	0.8872	0.8684	188
20	9	33.2424	0.8923	0.8724	199
20	10	34.2424	0.8971	0.8761	216
20	11	35.2424	0.9014	0.8796	218
20	12	36.2424	0.9055	0.8829	226
20	13	37.2424	0.9093	0.8860	233
20	14	38.2424	0.9129	0.8891	238
20	15	39.2424	0.9162	0.8919	243
20	16	40.2424	0.9193	0.8946	247
20	17	41.2424	0.9223	0.8971	252
20	18	42.2424	0.9250	0.8996	254
20	19	43.2424	0.9276	0.9019	257
20	20	44.2424	0.9300	0.9041	259
19	20	43.0303	0.9325	0.9063	262
18	20	48.1182	0.9349	0.9087	262

A.	W.	Volume.	Sp. Grav. obſerved.	Sp. Grav. calculated.	Condenſation.
17	20	40.6061	0.9375	0.9112	263
16	20	39.3939	0.9402	0.9139	263
15	20	38.1818	0.9430	0.9167	263
14	20	36.9697	0.9458	0.9197	261
13	20	35.7576	0.9488	0.9229	259
12	20	34.5455	0.9518	0.9263	255
11	20	33.3333	0.9549	0.9300	249
10	20	32.1212	0.9580	0.9340	240
9	20	30.9091	0.9612	0.9382	230
8	20	29.6970	0.9644	0.9429	215
7	20	28.4849	0.9675	0.9479	196
6	20	27.2727	0.9707	0.9533	174
5	20	26.0606	0.9741	0.9593	148
4	20	24.8485	0.9777	0.9659	118
3	20	23.6364	0.9818	0.9731	87
2	20	22.4242	0.9865	0.9811	54
1	20	21.2121	0.9924	0.9900	24
0	20	20.0000	1.0000	1.0000	

It is to be remarked, that the condenſation is greateſt when $16\frac{1}{2}$ ounces of alcohol have been added to 20 of water, and the condenſation is $\frac{2631}{92835}$, or nearly $\frac{1}{36}$th of the computed denſity. Since the ſpecific gravity of alcohol is 0.825, it is evident that $16\frac{1}{2}$ ounces of alcohol and 20 ounces of water have equal bulks. So that the condenſation is greateſt when the ſubſtances are mixed in equal volumes; and 18 gallons of alcohol mixed with 18 gallons of water will produce not 36 gallons of ſpirits, but 35 only.

We may alſo obſerve, that this is the mixture to which our revenue laws refer, declaring it to be *one to ſix* or *one in ſeven* under proof, and to weigh 7 pounds 13 ounce per gallon. This proportion was probably ſelected as the moſt eaſily compoſed, viz. by mixing equal meaſures of water and of the ſtrongeſt ſpirit which the known proceſſes of diſtillation could produce. Its ſpecific gravity is 0.939 very nearly.

We muſt conſider this elaborate examination of the mixture of water and alcohol as a ſtandard ſeries of experiments, to which appeal may always be made, whether for the purpoſes of ſcience or of trade. The regularity of the progreſſion is ſo great, that in the column which we have examined, viz. that for temperature 60°, the greateſt anomaly does not amount to one part in ſix thouſand. The form of the ſeries is alſo very judiciouſly choſen for the purpoſes of ſcience. It would perhaps have been more directly ſtereometrical had the proportions of the ingredients been ſtated in bulks, which are more immediately connected with denſity. But the author has aſſigned a very cogent reaſon for his choice, viz. that the proportion of bulks varies by a change of temperature, becauſe the water and ſpirits follow different laws in their expanſion by heat.

This is a proper opportunity for taking notice of a miſtake which is very generally made in the concluſions drawn from experiments of this kind. Equal additions of the ſpirit or water produce a ſeries of ſpecific gravities, which decreaſe or increaſe by differences continually diminiſhing. Hence it is inferred that there is a contraction of bulk. Even Dr Lewis, one of our moſt accompliſhed

complished naturalists, advances this position, in a dissertation on the potash of America; and it considerably affects his method for estimating the strength of the potash leys. But that it is a mistake, appears plainly from this, that although we add for ever equal quantities of the spirits, we shall never produce a *mixture* which has as small a specific gravity as alcohol. Therefore the series of successive gravities must approximate to this without end, like the ordinates of a hyperbolic curve referred to its assymptote.

That this may appear in the most general terms, let w represent the weight of the constant quantity of water in the mixture, and let a be the weight of the small addition of spirits. Also let w represent the bulk of this quantity of water, and b the bulk of the small addition of alcohol. The weight of the mixture is $w+a$, and its bulk is $w+b$, and its specific gravity is $\frac{w+a}{w+b}$. If we now add a second equal quantity of spirits, the weight will be $w+2a$, and if the spirit retains its density unchanged, the bulk will be $w+2b$, and the specific gravity is $\frac{w+2a}{w+2b}$: and after any number m of such equal additions of spirits, the specific gravity will be $\frac{w+ma}{w+mb}$. Divide the numerator of this fraction by its denominator, and the quotient or specific gravity will be $1+\frac{m\times\overline{a-b}}{w+mb}$. This consists of the constant part 1, and the variable part $\frac{m(a-b)}{w+mb}$. We need attend only to this part. If its denominator were constant, it is plain that the successive specific gravities would have equal differences, each being $=\frac{a-b}{w+mb}$, because m increases by the continual addition of an unit, and $a-b$ is a constant quantity. But the denominator $w+mb$ continually increases, and therefore the value of the fraction $\frac{a-b}{w+mb}$ continually diminishes.

Therefore the gradual diminution of the increments or decrements of specific gravity, by equal additions of one ingredient to a constant measure of the other, is not of itself an indication of a change of density of either of the ingredients; nor proves that in very diluted mixtures a greater proportion of one ingredient is absorbed or lodged in the interstices of the other, as is generally imagined. This must be ascertained by comparing each specific gravity with the gravity expressed by $1+\frac{w+m(a-b)}{w+mb}$.

This series of specific gravities resembles such a numerical series as the following, 1; . . . . ; 1.56; 1.163; 1.+69; &c. the terms of which also consist of the constant integer 1, and the decimal fractions 0.156; 0.163; 0.169; &c. The fraction $\frac{m(a-b)}{w+mb}$ expresses this decimal part. Call this d, or make $d=\frac{m(a-b)}{w+mb}$. This will give us $b=\frac{ma-wd}{m(1+d)}$. Now a is the weight of the added ingredient, and d is the variable part of the specific gravity observed; and thus we learn whether b, the bulk of the added ingredient, suffers any change. We shall have occasion by and by to resume the consideration of this question, which is of the first moment in the theory of specific gravities, and has great influence in many transactions of commerce.

This series of specific gravities is not so well fitted for commercial transactions. In these the usual question is, how many gallons of alcohol is there in a cask, or some number of gallons of spirit? and it is more directly answered by means of a table, formed by mixing the ingredients in aliquant parts of one constant bulk. The following table, constructed from the experiments of Mr Brisson of the academy of Paris, and published in the Memoirs for 1769, is therefore inserted.

W.	A.	Density observed.	Density computed.	Condensation.	Bulk of 10.000 grains..
0	16	0.8371	0.8371		1.0000
1	15	0.8527	0.8473	63	0.9937
2	14	0.8674	0.8575	115	0.9885
3	13	0.8815	0.8677	157	0.9844
4	12	0.8947	0.8778	189	0.9811
5	11	0.9075	0.8880	214	0.9786
6	10	0.9199	0.8982	235	0.9765
7	9	0.9317	0.9084	251	0.9749
8	8	0.9427	0.9186	256	0.9744
9	7	0.9519	0.9287	243	0.9757
10	6	0.9598	0.9389	217	0.9783
11	5	0.9674	0.9491	189	0.9811
12	4	0.9733	0.9593	144	0.9856
13	3	0.9791	0.9695	99	0.9901
14	2	0.9852	0.9796	57	0,9943
15	1	0.9919	0.9898	21	0.9979
16	0	1.0000	1.0000		1.0000

In this table the whole quantity of spirituous liquor is always the same. The first column is the number of measures (gallons, pints, inches, &c.) of water in the mixture: and column 2d gives the measures of alcohol. Column 3d is the specific gravity which was observed by Mr Brisson. Column 4th is the specific gravity which would have been observed if the spirits, or water, or both, had retained their specific density unchanged. And the 5th column marks the augmentation of specific gravity or density in parts of 10.000. A 6th column is added, showing the bulk of the 16 cubic measures of the two ingredients. Each measure may be conceived as the 16th part of 10.000, or 625; and we may suppose them cubic inches, pints, gallons, or any solid measure.

This table scarcely differs from Sir Charles Blagden's; and the very small difference that may be observed, arises from Mr Brisson's having used an alcohol not so completely rectified. Its specific gravity is 9,8371, whereas the other was only 0,8250.

Here it appears more distinctly that the condensation is greatest when the two ingredients are of equal bulk.

Perhaps this series of specific gravities is as declarative as the other, whether or not there is a change of density induced in either of the ingredients. The whole

whole bulk being always the same, it is plain that the successive equal additions to one of the ingredients is a successive equal abstraction of the other. The change produced, therefore, in the weight of the whole, is the difference between the weight of the ingredient which is taken out and the weight of the equal measure of the other which supplies its place. Therefore, if neither ingredient changes its density by mixture, the weights of the mixtures will be in arithmetical progression. If they are not, there is a variation of density in one or both the ingredients.

We see this very clearly in the mixtures of water and alcohol. The first specific gravity differs from the second by 156, and the last differs from the preceding by no more than 81. Had neither of the densities changed, the common difference would have been 102. We observe also, that the augmentation of specific gravity, by the successive addition of a measure of water, grows less and less till 12 measures of water is mixed with 4 of alcohol, when the augmentation is only 58, and then it increases again to 81.

It also appears, that the addition of one measure of water to a quantity of alcohol produces a greater change of density than the mixture of one measure of alcohol to a quantity of water. Hence some conclude, that the water disappears by being lodged in the interstices of the spirit. But it is more agreeable to the justest notions which we can form of the internal constitution of tangible bodies to suppose that the particles of water diminish the distances between the particles of alcohol by their strong attractions, and that this diminution (exceedingly minute in itself) becomes sensible on account of the great number of particles whose distances are thus diminished. This is merely a probability founded on this, that it would require a much greater diminution of distances if it was the particles of water which had their distances thus diminished. But the greater probability is, that the condensation takes place in both.

We have been so particular in our consideration of this mixture, because the law of variation of density has, in this instance, been ascertained with such precision by the elaborate examination of Sir Charles Blagden, so that it may serve as an example of what happens in almost every mixture of bodies. It merits a still farther discussion, because it is intimately connected with the action of the corpuscular forces; and an exact knowledge of the variations of distance between the particles will go far to ascertain the law of action of these forces. But the limits of a work like this will not permit us to dwell longer on this subject. We proceed therefore to give another useful table.

The vitriolic or sulphuric acid is of extensive use in manufactures under the name of oil of vitriol. Its value depends entirely on the saline ingredient, and the water is merely a vehicle for the acid. This, being much denser than water, affects its specific gravity, and thus gives us a method of ascertaining its strength.

The strongest oil of vitriol that can be easily manufactured contains $612\frac{1}{10}$ grains of dry acid, united with $387\frac{1}{10}$ grains of water, which cannot be separated from it by distillation, making 1000 grains of OIL OF VITRIOL. Its specific gravity in this state is 1.877.

The following table shows its specific gravity at the temperature of 55° when diluted by the successive addition of parts of water by weight.

Ol. Vit.		Water.	Specific Gravity. Observed.	Calculated.	Cond.
10	×	0	1.877	1.877	.00
		4	1.644	1.501	.143
		8	1.474	1.350	.124
		12	1.381	1.269	.112
		16	1.320	1.219	.101
		20	1.274	1.184	.090
		24	1.243	1.159	.084
		28	1.211	1.140	.071
		32	1.195	1.125	.070
		36	1.183	1.113	.070
		40	1.172	1.103	.070
		50	1.148	1.084	.064
		60	1.128	1.069	.059

Here is observed a much greater condensation than in the mixture of alcohol and water. But we cannot assign the proportion of ingredients which produces the greatest condensation; because we cannot, in any case, say what is the proportion of the saline and watery ingredients. The strongest oil of vitriol is already a watery solution; and it is by a considerable and uncertain detour that Mr Kirwan has assigned the proportion of 612 and 388 nearly. If this be the true ratio, it is unlike every other solution that we are acquainted with; for in all solutions of salts, the salt occupies less room in its liquid form than it did when solid; and here it would be greatly the reverse.

This solution is remarkable also for the copious emergence of heat in its dilutions with more water. This has been ascribed to the great superiority of water in its capacity for heat; but there are facts which render this very doubtful. A vessel of water, and another of oil of vitriol, being brought from a cold room into a warm one, they both imbibe heat, and rise in their temperature; and the water employs nearly the same time to attain the temperature of the room.

Aquafortis or nitrous acid is another fluid very much employed in commerce; so that it is of importance to ascertain the relation between its saline strength and its specific gravity. We owe also to Mr Kirwan a table for this purpose.

The most concentrated state into which it can easily be brought is such, that 1000 grains of it consists of 563 grains of water and 437 of dry acid. In this state its specific gravity is 1.557. Let this be called *nitrous acid*.

Nitr. Ac.		Water.			
10	×	0	1.557	1.557	
		1	1.474	1.474	
		6	1.350	1.273	0.077
		11	1.269	1.191	0.078
		16	1.214	1.147	0.067
		21	1.175	1.120	0.055
		26	1.151	1.101	0.050
		31	1.127	1.087	0.040
		36	1.106	1.077	0.029
		41	1.086	1.068	0.018

There is not the same uniformity in the densities of this acid in its different states of dilution. This seems owing

owing to the variable proportion of the deleterious and vital air which compose this acid. It is more dense in proportion as it contains more of the latter ingredient.

The proportions of the aeriform ingredients of the muriatic acid are so very variable, and so little under our command, that we cannot frame tables of its specific gravity which would enable us to judge of its strength.

It is a general property of these acids, that they are more expansible by heat as they are more concentrated.

There is another class of fluids which it would be of great consequence to reduce to some rules with respect to specific gravity, namely, the solutions of salts, gums, and resins. It is interesting to the philosopher to know in what manner salts are contained in these watery solutions, and to discover the relation between their strength and density; and to the man of business it would be a most desirable thing to have a criterion of the quantity of salt in any brine, or of extractable matter in a decoction. It would be equally desirable to those who are to purchase them as to those who manufacture or employ them. Perhaps we might ascertain in this way the value of sugar, depending on the quantity of sweetening matter which it contains; a thing which at present rests on the vague determination of the eye or palate. It would therefore be doing a great service to the public, if some intelligent person would undertake a train of experiments with this view. Accuracy alone is required; and it may be left to the philosophers to compare the facts, and draw the consequences respecting the internal arrangement of the particles.

One circumstance in the solution of salts is very general; and we are inclined, for serious reasons, to think it universal: this is a diminution of bulk. This indeed in some salts is inconsiderable. Sedative salt, for instance, hardly shows any diminution, and might be considered as an exception, were it not the single instance. This circumstance, and some considerations connected with our notions of this kind of solution, dispose us to think that this salt differs in contraction from others only in degree, and that there is some, though it was not sensible, in the experiments hitherto made.

These experiments, indeed, have not been numerous. Those of Mr Achard of Berlin, and of Dr Richard Watson of Cambridge, are perhaps the only ones of which we have a descriptive narration, by which we can judge of the validity of the inferences drawn from them. The subject is not susceptible of much accuracy; for salts in their solid form are seldom free from cavities and shivery interstices, which do not admit the water on their first immersion, and thereby appear of greater bulk when we attempt to measure their specific gravity by weighing them in fluids which do not dissolve them, such as spirits of turpentine. They also attach to themselves, with considerable tenacity, a quantity of atmospheric air, which merely adheres, but makes no part of their composition. This escapes in the act of solution, being set at liberty by the stronger affinity of the water. Sal gem, however, and a few others, may be very accurately measured; and in these instances the degree of contraction is very constant.

The following experiments of Dr Watson appear to us the most instructive as to this circumstance. A glass vessel was used, having a slender cylindrical neck, and holding 67 ounces of pure water when filled to a certain mark. The neck above this mark had a scale of equal parts pasted on it. It was filled to the mark with water. Twenty-four pennyweights of salt were thrown into it as speedily as possible, and the bulk of the salt was measured by the elevation of the water. Every thing was attended to which could retard the immediate solution, that the error arising from the solution of the first particles, before the rest could be put in, might be as small as possible; and in order that both the absolute bulk and its variations might be obtained by some known scale, 24 pennyweights of water were put in. This raised the surface 58 parts of the scale. Now we know exactly the bulk of 24 pennyweights of pure water. It is 2.275 cubic inches; and thus we obtain every thing in absolute measures: And by comparing the bulk of each salt, both at its first immersion and after its complete solution, we obtain its specific gravity, and the change made on it in passing from a solid to a fluid form. The following table is an abstract of these experiments. The first column of numbers is the elevation of the surface immediately after immersion; the second gives the elevation when the salt is completely dissolved; and the third and fourth columns are the specific gravities of the salts in these two states.

Twenty-four Pennyweights.	I.	II	III.	IV.
Water -	58			
Glauber's salt -	42	36	1.380	1.611
Mild volatile alkali -	40	33	1.450	1.787
Sal ammoniac -	40	39	1.450	1.487
Refined white sugar -	39	36	1.487	1.611
Coarse brown sugar -	39	36	1.487	1.611
White sugar candy -	37	36	1.567	1.611
Lymington Glauber's salt	35	29	1.657	2.000
Terra foliata tartari -	37	30	1.567	1.933
Rochelle salt -	33	28	1.757	2.071
Alum not quite dissolved	33	28	1.757	2.061
Borax not one-half dissolved in two days -	33	31	1.757	
Green vitriol -	32	26	1.812	2.230
White vitriol -	30	24	1.933	2.416
Nitre - -	30	21	1.933	2.766
Sal gem from Northwich	27	17	2.143	3.411
Blue vitriol -	26	20	2.230	2.900
Pearl ashes -	25	10	2.320	5.800
Tart. vitriolatus -	22	11	2.636	5.272
Green vitriol calcined to white -	22	11	2.636	5.272
Dry salt of tartar -	21	13	2.761	4.461
Basket sea-salt -	19	15	3.052	3.866
Corrosive sublimate -	14	10	4.142	3.800
Turbith mineral -	9	0	6.444	

The inspection of this list naturally suggests two states of the case as particularly interesting to the philosopher studying the theory of solution. The first state is when the lixivium approaches to saturation. In the very point of saturation any addition of salt retains its bulk unchanged. In diluted brines, we shall see that the density

sity

Specific Gravity.

fity of the fluid falt is greater, and gradually diminifhes as we add more falt. It is an important queftion, Whether this diminution goes on continually, till the fluid denfity of the falt is the fame with its folid denfity? or, Whether there is an abrupt paffage from fome degree of the one to the fixed degree of the other, as we obferve in the freezing of iron, the fetting of ftucco, and fome other inftances?

The other interefting ftate is that of extreme dilution, when the differences between the fucceffive denfities bear a great proportion to the denfities themfelves, and thus enable the mathematician to afcertain with fome precifion the variations of corpufcular force, in confequence of a variation of diftance between the particles. The fketch of an inveftigation of this important queftion given by Bofcovich, in his Theory of Natural Philofophy, is very promifing, and fhould incite the philofophical chemift to the ftudy. The firft thing to be done is to compare the law of fpecific gravity; that is, the relation between the fpecific gravity and quantity of falt held in folution.

Wifhing to make this work as ufeful as poffible, we have fearched for experiments, and trains of experiments, on the denfity of the many brines which make important articles of commerce; but we were mortified by the fcantinefs of the information, and difappointed in our hopes of being able to combine the detached obfervations, fuited to the immediate views of their authors, in fuch a manner as to deduce from them fcales (as they may be called) of their ftrength. We rarely found thefe detached obfervations attended with circumftances which would connect them with others; and there was frequently fuch a difcrepancy, nay oppofition, in feriefes of experiments made for afcertaining the relation between the denfity and the ftrength, that we could not obtain general principles which enable us to conftruct tables of ftrength *à priori*.

Mr Lambert, one of the firft mathematicians and philofophers of Europe, in a differtation in the Berlin Memoirs (1762), gives a narration of experiments on the brines of common falt, from which he deduces a very great condenfation, which he attributes to an abforption in the weak brines of the falt, or a lodgement of its particles in the interftices of the particles of water. Mr Achard of the fame academy, in 1785, gives a very great lift of experiments on the bulks of various brines, made in a different way, which fhow no fuch introfufception; and Dr Watfon thinks this confirmed by experiments which he narrates in his Chemical Effays. We fee great reafon for hefitating our affent to either fide, and do not think the experiments decifive. We incline to Mr Lambert's opinion; for this reafon, that in the fucceffive dilutions of oil of vitriol and aquafortis there is a moft evident and remarkable condenfation. Now what are thefe but brines, of which we have not been able to get the faline ingredient in a feparate form? The experiments of Mr Achard and Dr Watfon were made in fuch a way that a fingle grain in the meafurement bore too great a proportion to the whole change of fpecific gravity. At the fame time, fome of Dr Watfon's are fo fimple in their nature that it is very difficult to with-hold the affent.

In this ftate of uncertainty, in a fubject which feems to us to be of public importance, we thought it our duty to undertake a train of experiments to which recourfe may always be had. Works like this are feldom confidered as fources of original information; and it is thought fufficient when the knowledge already diffufed is judicioufly compiled. But a due refpect for the public, and gratitude for the very honourable reception hitherto given to our labours, induce us to exert ourfelves with honeft zeal to merit the continuance of public favour. We affure our readers that the experiments were made with care, and on quantities fufficiently large to make the unavoidable irregularities in fuch cafes quite infignificant. The law of denfity was afcertained in each fubftance in two ways. We diffolved different portions of falt in the fame quantity of water, and examined the fpecific gravity of the brine by weighing it in a veffel with a narrow neck. The portions of falt were each of them one eighth of what would make a nearly faturated folution of the temperature 55. We did not make the brine ftronger, that there might be no rifk of a precipitation in form of cryftals. We confidered the fpecific gravities as the ordinates of a curve, of which the abfciffæ were the numbers of ounces of dry falt contained in a cubic foot of the brine. Having thus obtained eight ordinates correfponding to 1, 2, 3, 4, 5, 6, 7, and 8 portions of falt, the ordinates or fpecific gravities for every other proportion of falt were had by the ufual methods of interpofition.

The other method was, by firft making a brine nearly faturated, in which the proportion of falt and water was exactly determined. We then took out one-eighth of the brine, and filled up the veffel with water, taking care that the mixture fhould be complete; for which purpofe, befides agitation, the diluted brine was allowed to remain 24 hours before weighing. Taking out one-eighth of the brine alfo takes out one eighth of the falt; fo that the proportion of falt and water in the diluted brine was known. It was now weighed, and thus we determined the fpecific gravity for a new proportion of falt and water.

We then took out one-feventh of the brine. It is evident that this takes out one-eighth of the original quantity of falt; an abftraction equal to the former. We filled the veffel with water with the fame precautions; and in the fame manner we proceeded till there remained only one-eighth of the original quantity of falt.

The fpecific gravities by thefe two methods agreed extremely well. In the very deliquefcent falts the firft method exhibited fome fmall irregularities, arifing from the unequal quantities of water which they had imbibed from the atmofphere. We therefore confided moft in the experiments made with diluted brines.

That the reader may judge of the authority of the tables which we fhall infert, we fubmit to his infpection one feries of experiments.

Two thoufand one hundred and eighty-eight grains of very pure and dry (but not decrepitated) common falt, prepared in large cryftals, were diffolved in 6562 grains of diftilled water of the temperature 55°. A fmall matrafs with a narrow neck, which held 4200 grains of diftilled water, was filled with this brine. Its contents weighed 5027 grains. Now $6562 + 2188 : 2188 = 5027 : 1256.75$. Therefore the bottle of brine contained 1256.75 grains of falt diffolved in 3770.25 grains of water. Its fpecific gravity is $= \frac{5027}{4200}$, or 1.196905: and a cubic foot of brine weighs 11969

Specific Gravity.

1196.9 ounces avoirdupois. Alſo 5027 : 1256.75 = 1196.9 : 299.28. Therefore a cubic foot of this brine contains 299.28 ounces of perfectly dry ſalt.

The ſubſequent ſteps of the proceſs are repreſented as follows.

Salt.	Brine.	Water.	Wt. of Cub Ft.	Salt in Cub. Ft.
8)1256.75 157.1	8)5027 628.4	3770.25 $=\frac{1}{8}$ of brine.	1196.9	299.28 37.41 $\frac{1}{8}$
	4398.6 527.4	Remains. Water to fill it again.		
7)1099.6 157.1	7)4926.0 703.7	2d Brine. $\frac{1}{7}$ taken out.	1172.7	261.87 37.41
	4222.3 604.7	Water added.		
942.5 157.1	6)4827.0 804.5	3d Brine. Taken out.	1149.3	224.46
	4022.5 706.5	Remains. Water added.		
785.4 157.1	5)4729.0 946	4th Brine. Taken out.	1125.9	187.05
	3783 847	Remains. Water added.		
628.3 157.1	4)4630 1157.5	5th Brine. Taken out.	1102.3	149.64
	3472.5 1054.5	Remains. Water added.		
471.2 157.1	3)4527 1509	6th Brine. Taken out.	1077.9	112.23
	3018 1405	Remains. Water added.		
314.1 157.1	2)4423 2212	7th Brine. Taken out.	1053.3	74.82
	2211 2102	Remains. Water added.		
157.0	4313	8th Brine.	1027.9	37.41

Thus, by repeated abſtraction of brine, ſo as always to take out $\frac{1}{8}$th of the ſalt contained in one conſtant bulk, we have obtained a brine conſiſting of 157 grains of ſalt united with 4313—157, or 4156 grains of water. Its ſpecific gravity is $\frac{4313}{4200}$, = 1,0279, and a cubic foot of it weighs 1028 ounces, and contains $37\frac{4}{10}$ ounces of dry ſalt. In like manner may the ſpecific gravity, the weight of a cubic foot, and the ſalt it contains, be eſtimated for the intermediate brines.

When theſe eight quantities of ſalt contained in a cubic foot are made the abſciſſæ, and the weights of the cubic foot of brine are the correſponding ordinates, the curve will be found to be extremely regular, reſembling a hyperbolic arch whoſe aſſymptote makes an angle of 30° with the axis. Ordinates were then interpolated analytically for every 10 ounces of contained ſalt, and thus the table was conſtructed. We did not, however, reſt it on one ſeries alone; but made others, in which one-fourth of the ſalt was repeatedly abſtracted. They agreed, in the caſe of common ſalt, with great exactneſs, and in ſome others there were ſome very inconſiderable irregularities.

To ſhow the authority of the tables of ſtrength was by no means our only motive for giving an example of the proceſs. It may be of uſe as a pattern for ſimilar experiments. But, beſides, it is very inſtructive. We ſee, in the firſt place, that there is a very ſenſible change of denſity in one or both of the ingredients. For the ſeries is of that nature (as we have formerly explained), that if the ingredients retained their denſities in every proportion of commixture, the ſpecific gravities would have been in arithmetical progreſſion; whereas we ſee that their differences continually diminiſh as the brines grow more denſe. We can form ſome notion of this by comparing the different brines. Thus in the firſt brine, weighing 5027 grains, there are 3770 grains of water in a veſſel holding 4200. If the denſity of the water remains the ſame, there is left for the ſalt only as much ſpace as would hold 430 grains of water. In this ſpace are lodged 1257 grains of ſalt, and its ſpecific gravity, in its liquid form, is $\frac{1257}{430}$, = 2.8907 very nearly. But in the 8th brine the quantity of water is 4156, the ſpace left for 157 grains of ſalt is only the bulk of 44 grains of water, and the denſity of the ſalt is $\frac{157}{44} = 3.568$, conſiderably greater than before. This induced us to continue the dilution of the brine as follows, beginning with the 8th brine.

157 78.5	2)4313 2156.5	8th brine
	2156.5 2105.5	
78.5 39.7	2)4262.0 2131	9th brine
	2102	
39.7	2)4233 2116.5	10th brine
	2116.5 2102	
19.8	4218	11th brine.

This laſt brine contains 4198.2 grains of water, leaving only the bulk of 1.8 grains of water to contain 19.8 of ſalt, ſo that the ſalt is ten times denſer than water. This will make the ſtrength 243 inſtead of 210 indicated by the ſpecific gravity. But we do not pretend to meaſure the denſities with accuracy in theſe diluted brines. It is evident from the proceſs that a ſingle

ſingle grain of exceſs or defect in taking out the brine and replacing it with water has a ſenſible proportion to the whole variation. But we ſee with ſufficient evidence, that from the ſtrong to the weak brines the ſpace left for the portion of ſalt is continually diminiſhing. In the firſt dilution 527½ grains of water were added to fill up the veſſel; but one-eighth of its contents of pure water is only 525: ſo that here is a diminution of two grains and a half in the ſpace occupied by the remaining ſalt. The ſubſequent additions are 604.7; 706.5; 847; 1054.5; 1405; 2102; 2105.5; 2102; 2102; inſtead of 600; 700; 840; 1050; 1400; 2100; 2100; 2100; 2100. Nothing can more plainly ſhow the condenſation in general, though we do not learn whether it happens in one or both of the ingredients; nor do the experiments ſhow with ſufficient accuracy the progreſſion of this diminution. The exceſſes of the added water being only ſix or ſeven grains, we cannot expect a nice repartition. When the brine is taken out, the upper part of the veſſel remains lined with a briny film containing a portion of ſalt and water, perhaps equal or ſuperior to the differences. Had our time permitted, we ſhould have examined this matter with ſcrupulous attention, uſing a veſſel with a ſtill narrower neck, and in each dilution abſtracting one half of the brine. The curve, whoſe abſciſſæ and ordinates repreſent the weight of the contained ſalt and the weight of a conſtant bulk of the brine, exhibits the beſt and moſt ſynoptical view of the law of condenſation, becauſe the poſition of the tangent in any point, or the value of the ſymbol $\frac{\dot{x}}{\dot{y}}$, always ſhows the rate at which the ſpecific gravity increaſes or diminiſhes. We are inclined to think that the curve in all caſes is of the hyperbolic kind, and complete; that is, having the tangent perpendicular to the axis at the beginning of the curve. The mathematical reader will eaſily gueſs the phyſical notions which incline us to this opinion; and will alſo ſee that it is hardly poſſible to diſcover this experimentally, becauſe the miſtake of a ſingle grain in the very ſmall ordinates will change the poſition of the tangent many degrees. It was for this reaſon that we thought it uſeleſs to proſecute the dilution any farther. But we think that it may be proſecuted much farther in Dr Watſon's or Mr Achard's method, viz. by diſſolving equal weights of ſalt in two veſſels, of very different capacities, having tubular necks, in which the change of bulk may be very accurately obſerved. We can only conclude, that the condenſation is greateſt in the ſtrongeſt brines, and probably attains its maximum when the quantities of true ſaline matter and water are nearly equal, as in the caſe of vitriolic acid, &c.

We conſider theſe experiments as abundantly ſufficient for deciding the queſtion "Whether the ſalt can be received into the pores of the water, or the water into the pores of the ſalt, ſo as to increaſe its weight without increaſing its bulk? and we muſt grant that it may. We do not mean that it is ſimply lodged in the pores as ſand is lodged in the interſtices of ſmall ſhot; but the two together occupy leſs room than when ſeparate. The experiments of Mr Achard were inſufficient for a deciſion, becauſe made on ſo ſmall a quantity as 600 grains of water. Dr Watſon's experiments have, for the moſt part, the ſame defect. Some of them, however, are of great value in this queſtion, and are very fit for aſcertaining the ſpecific gravity of diſſolved ſalts. In one of them (not particularly narrated) he found that a quantity of diſſolved ſalt occupied the ſame bulk in two very different ſtates of dilution. We cannot pretend to reconcile this with our experiments. We have given theſe as they ſtood; and we think them concluſive, becauſe they were ſo numerous and ſo perfectly conſiſtent with each other; and their reſult is ſo general, that we have not found an exception. Common ſalt is by no means the moſt remarkable inſtance of condenſation. Vegetable alkali, ſal ammoniac, and ſome others, exhibit much condenſation.

We thought this a proper opportunity of conſidering this queſtion, which is intimately connected with the principles of chemical ſolution, and was not perhaps conſidered in ſufficient detail under the article CHEMISTRY. We learn from it in general, that the quantities of ſalt in brines increaſe at ſomewhat a greater rate than their ſpecific gravities. This difference is in many caſes of ſenſible importance in a commercial view. Thus an alkaline lixivium for the purpoſes of bleaching or ſoap-making, whoſe ſpecific gravity is 1.234, or exceeds that of water by 234, contains 361 ounces of ſalt in a cubic foot; a ley, which exceeds the weight of water twice as much, or 468 ounces per cubic foot, contains 777 ounces of ſalt, which exceeds the double of 361 by 55 ounces more that ſeven per cent. Hence we learn, that hydrometers for diſcovering the ſtrength of brines, having equal diviſions on a cylindrical ſtem, are very erroneous; for even if the increments of ſpecific gravity were proportional to the quantities of ſalt in a gallon of brine, the diviſions at the bottom of the ſtem ought to be ſmaller than thoſe above.

The conſtruction of the following table of ſtrengths from the above narrated ſeries of brines is ſufficiently obvious. Column 1ſt is the ſpecific gravity as diſcovered by the balance or hydrometer, and alſo is the number of ounces in a cubic foot of the brine. Col. 2d is the ounces of the dry ſalt contained in it.

TABLE of Brines of Common Salt.

Weight Cub Ft. Brine.	Salt in Cub.Ft.	Weight Cub. Ft. Brine.	Salt in Cub.Ft.
1.000	0	1.115	170
1.008	10	1.122	180
1.015	20	1.128	190
1.022	30	1.134	200
1.029	40	1.140	210
1.036	50	1.147	220
1.043	60	1.153	230
1.050	70	1.159	240
1.057	80	1.165	250
1.064	90	1.172	260
1.070	100	1.178	270
1.077	110	1.184	280
1.083	120	1.190	290
1.090	130	1.197	300
1.096	140	1.203	310
1.103	150	1.206	316
1.109	160	1.208	320

The table differs confiderably from Mr Lambert's. The quantities of falt correfponding to any fpecific gravity are about $\frac{1}{15}$th lefs than in his table. But the reader will fee that they correfpond with the feries of experiments above narrated; and thefe were but a few of many which all correfponded within an hundredth part. The caufe of the difference feems to be, that moft kinds of common falt contain magnefian falts, which contain a very great proportion of water neceffary for their cryftallization. The falt which we ufed was of the pureft kind, but fuch as may be had from every falt work, by Lord Dundonald's very eafy procefs, viz. by paffing through it a faturated folution boiling hot, which carries off with it about four-fifths of all the bitter falts. Our aim being to afcertain the quantities of pure fea-falt, and to learn by the bye its relation to water in refpect of denfity, we thought it neceffary to ufe the pureft falt. We alfo dried it for feveral days in a ftove, fo that it contained no water not abfolutely neceffary for its cryftallization. An ounce of fuch falt will communicate a greater fpecific gravity to water than an ounce of a falt that is lefs pure, or that contains extraneous water.

The fpecific gravity 1.090 is that of ordinary pickles, which are eftimated as to ftrength by floating an egg.

We cannot raife the fpecific gravity higher than 1.206 by fimply diffolving falt in cold water. But it will become much denfer, and will even attain the fpecific gravity 1.240 by boiling, then holding about 366 ounces in the cubic foot of hot brine. But it will depofit by cooling, and when of the temperature 55° or 60°, hardly exceeds 1,206. We obtained a brine by boiling till the falt grained very rapidly. When it cooled to 60°, its fpecific gravity was 1.2063; for a veffel which held 3506 grains of diftilled water held 4229 of this brine. This was evaporated to drynefs, and there were obtained 1344 grains of falt. By this was computed the number interpofed between 310 and 320 in the table. We have, however, raifed the fpecific gravity to 1.217, by putting in no more falt than was neceffary for this denfity, and ufing heat. It then cooled down to 60° without quitting any falt; but if a few grains of falt be thrown into this brine, it will quickly depofit a great de l more, and its denfity will decreafe to 1.206. We find this to hold in all falts; and it is a very inftructive fact in the theory of cryftallization; it refembles the effect which a magnet produces upon iron filings in its neighbourhood. It makes them temporary magnets, and caufes them to arrange themfelves as if they had been really made permanent magnets. Juft fo a cryftal already formed difpofes the reft to cryftallize. We imagine that this analogy is complete, and that the forces are fimilar in both cafes.

The above table is computed for the temoerature 55°; but in other temperatures the ftrength will be different on two accounts, viz. the expanfion of the brine and the diffolving power of the water. Water expands about 40 parts in 1000 when heated from 60° to 212°. Saturated brine expands about 48 parts, or one-fifth more than water; and this excefs of expanfion is nearly proportional to the quantity of falt in the brine. If therefore any circumftance fhould oblige us to examine a brine in a temperature much above 60°, allowance fhould be made for this. Thus, fhould the fpecific gravity of brine of the temperature 130 (which is nearly half way between 60 and 212) be 1.140, we muft increafe it by 20 (half of 40); and having found the ftrength 240 correfponding to this corrected fpecific gravity, we muft correct it again by adding 1 to the fpecific gravity for every 45 ounces of falt.

But a much greater and more uncertain correction is neceffary on account of the variation of the diffolving power of water by heat. This indeed is very fmall in the cafe of fea-falt in comparifon with other falts. We prefume that our readers are apprifed of this peculiarity of fea-falt, that it diffolves nearly in equal quantities in hot or in cold water. But although water of the temperature 60 will not diffolve more than 320 or 325 ounces of the pureft and dryeft fea-falt, it will take up above 20 ounces more by boiling on it. When thus faturated to the utmoft, and allowed to cool, it does not quit any of it till it is far cooled, viz. near to 60°. It then depofits this redundant falt, and holds the reft till it is juft going to freeze, when it lets it go in the inftant of freezing. If evaporated in the ftate in which it continues to hold the falt, it will yield above 400 ounces per cubic foot of brine, in good cryftals, but rather overcharged with water. And fince in this ftate the cubic foot of brine weighs about 1220 ounces, it follows, that 820 ounces of water will, by boiling, diffolve 400 of cryftallized falt.

The table fhows how much any brine muft be boiled down in order to grain. Having obferved its fpecific gravity, find in the table the quantity of falt correfponding. Call this x. Then, fince a boiling hot graining or faturated folution contains 340 ounces in the cubic foot of brine, fay $340 : 1000 = x : \frac{1000}{340}x$. This is the bulk to which every cubic foot (valued at 1000) muft be boiled down. Thus fuppofe the brine has the fpecific gravity 1109. It holds 160 ounces per foot, and we muft boil it down to $\frac{1000 \times 160}{340}$ or 471; that is, we muft boil off $\frac{529}{1000}$ of every cubit foot or gallon.

Thefe remarks are of importance in the manufacture of common falt; they enable us to appretiate the value of falt fprings, and to know how far it may be prudent to engage in the manufacture. For the doctrine of latent heat affures us, that in order to boil off a certain quantity of water, a certain quantity of heat is indifpenfably neceffary. After the moft judicious application of this heat, the confumption of fuel may be too expenfive.

The fpecific gravity of fea-water in thefe climates does not exceed 1.03, or the cubic foot weighs 1030 ounces, and it contains about 41 ounces of falt. The brine-pits in England are vaftly richer; but in many parts of the world brines are boiled for falt which do not contain above 10 or 20 ounces in the cubic foot.

In buying falt by weight, it is of importance to know the degree of humidity. A falt will appear pretty dry (if free from magnefian falts) though moiftened with one per cent. of water; and it is found that incipient humidity expofes it much to farther deliquefcence. A much fmaller degree of humidity may be difcovered by the fpecific gravity of a brine made with a few ounces of the falt. And the infpection of the table informs us, that

that the brine should be weak; for the differences of specific gravity go on diminishing in the stronger brines: 300 ounces of dry salt dissolved in 897 ounces of water should give the specific gravity 1197. Suppose it be but 1190, the quantity of salt corresponding is only 290; but when mixed with 897 ounces of water, the weight is 1197, although the weight of the cubic foot is only 1190. There is therefore more than a cubic foot of the brine, and there is as much salt as will make more than a cubic foot of the weight 1190. There is $290 \times \frac{1197}{1190}$, or $291\frac{2}{3}$ ounces, and there is $8\frac{1}{3}$ ounces of water attached to the salt.

The various informations which we have pointed out as deducible from a knowledge of the specific gravity of the brines of common salt, will serve to suggest several advantages of the knowledge of this circumstance in other lixivia. We shall not therefore resume them, but simply give another table or two of such as are most interesting. Of those, alkaline leys are the chief, being of extensive use in bleaching, soap-making, glass-making, &c.

We therefore made a very strong ley of the purest vegetable alkali that is ever used in the manufactories, not thinking it necessary, or even proper, to take it in its state of utmost purity, as obtained from cubic nitre and the like. We took salt of tartar from the apothecary, perfectly dry, of which 3983 grains were dissolved in 3540 grains of distilled water; and after agitation for several days, and then standing to deposit sediment, the clear ley was decanted. It was again agitated; because, when of this strength, it becomes, in a very short time, rarer above and denser at the bottom. A flask containing 4200 grains of water held 6165 of this ley when of the temperature 55°. Its specific gravity was therefore 1.4678, and the 6165 grains of ley contained 3264 grains of salt. We examined its specific gravity in different states of dilution, till we came to a brine containing 51 grains of salt, and 4189 grains of water, and the contents of the flask weighed 4240 grains: its specific gravity was therefore 1.0095. In this train of experiments the progression was most regular and satisfactory; so that when we constructed the curve of specific gravities geometrically, none of the points deviated from a most regular curve. It was considerably more incurvated near its commencement than the curve for sea-salt, indicating a much greater condensation in the diluted brines. We think that the following table, constructed in the same manner as that for common salt, may be depended on as very exact.

Weight of Cub. Foot. oz.	Salt cont. oz.	Weight of Cub. Foot oz.	Salt cont. oz.	Weight of Cub. Foot oz.	Salt cont. oz.	Weight of Cub. Foot oz.	Salt cont. oz.
1000	0	1174	260	1329	520	1471	780
1016	20	1187	280	1340	540	1482	800
1031	40	1200	300	1351	560	1493	820
1045	60	1212	320	1362	580	1504	840
1085	80	1224	340	1372	600	1515	860
1071	100	1236	360	1384	620	1526	880
1084	120	1248	380	1395	640	1537	900
1098	140	1259	400	1406	660	1547	920
1112	160	1270	420	1417	680	1557	940
1125	180	1281	440	1428	700	1567	960
1138	200	1293	460	1438	720	1577	980
1150	220	1305	480	1449	740	1586	1000
1162	240	1317	500	1460	760		

We see the same augmentation of the density of the salt in the diluted brines here as in the case of common salt. Thus a brine, of which the cubit foot weighs 1482 ounces, or which has the specific gravity 1.482, contains 800 ounces of dry alkali and 682 of water. Therefore, if we suppose the density of the water unchanged, there remains the bulk of 318 ounces of water to receive 840 ounces of salt: its density is therefore $\frac{800}{318}$, $= 2.512$ nearly. But in the brine whose weight per foot is only 1016 there are 20 ounces of salt, and therefore 996 of water; and there is only four ounce-measures of water, that is, the bulk of four ounces of water, to receive 20 ounces of salt. Its specific gravity therefore is $\frac{20}{4}, = 5$, almost twice as great as in the strong brine. Accordingly Mr Achard is disposed to admit the absorption (as it is carelessly termed) in the case of sal tart. But it is a general (we think an universal) fact in the solution of salts. It must be carefully distinguished from the first contraction of bulk which salts undergo in passing from a solid to a fluid form. The contraction now under consideration is analogous to the contraction of oil of vitriol when diluted with water; for oil of vitriol must be considered as a very strong brine which we cannot dephlegmate by distillation, and therefore cannot obtain the dry saline ingredient in a separate form, so as to observe its solid density, and say how much it contracts in first becoming fluid. The way of conceiving the first contraction in the act of solution as a lodging of the particles of the one ingredient on the interstices of theo ther, "*qu' ils se nichent, en augmentant le poids sans affecter le volume de la saumure*," as Euler and Lambert express themselves, is impossible here, when both are fluids. Indeed it is but a slovenly way of

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Specific Gravity.

thinking in either cafe, and fhould be avoided, becaufe inadvertent perfons are apt to ufe as a phyfical principle what is merely a mode of fpeech.

We learn from the table, that a hydrometer with equi-diftant divifions on a cylindrical or prifmatical ftem is ftill more erroneous than in the brines of common falt.

We learn from the experiments of Kirwan, Lavoifier, and others, that dry falt of tartar contains about one-fourth of its weight of fixed air. In many applications of this falt to the purpofes of manufacture, this ingredient is of no ufe. In fome it is hurtful, and muft be abftracted by lime. Soap-maker's ley confifts of the pure alkaline falt diffolved in water. It is therefore of importance to afcertain its quantity by means of the fpecific gravity of the brine. For this purpofe we took a ley of fal tart. whofe fpecific gravity was 1.20417, containing 314 ounces of mild alkali in a cubic foot of ley, and we rendered it nearly cauftic by lime. The fpecific gravity was then 1.1897. This is a very unexpected refult. Nothing is employed with more fuccefs than quicklime for dephlegmating any watery fluid. We fhould rather have expected an increafe of fpecific gravity by the abftraction of fome of the water of the menftruum, and perhaps the water of the cryftallization, and the aerial part of the falt. But we muft afcribe this to the great denfity in which the fixed air exifts in the mild alkali.

It is unneceffary to give fimilar tables for all the falts, unlefs we were writing a differtation on the theory of their folution. We fhall only obferve, that we examined with particular attention fal ammoniac, becaufe Mr Achard, who denies what is called the abforption of falts, finds himfelf obliged to allow fomething like it in this falt. It does not, however, differ from thofe of which we have given an account in detail in any other refpect than this, that the changes of fluid denfity are much lefs than in others (inftead of being greater, as Achard's experiments feem to indicate) in all brines of moderate ftrength. But in the very weak brines there is indeed a remarkable difference; and if we have not committed an error in our examination, the addition of one part of fal ammoniac to 64 of water occupies lefs room than the water alone. We think that we have met with this as an accidental remark by fome author, whofe work we do not recollect. But we do not choofe to reft fo much on our form of the experiment in fuch weak brines. The following mixtures will abundantly ferve for conftructing the table of its ftrength: Sal ammoniac $=960$ grains was diffolved in 3506 grains of water, making a brine of 4466 grains. A phial which held 1600 grains water held 1698 of this brine. It contained $\frac{1698 \times 960}{4466}$, or 365 grains of falt. The fpecific gravity was $\frac{1698}{1600}, = 1.061$, and the cubic foot weighed 1061 ounces. It alfo contained $\frac{1061 \times 365}{1698}$, or 288 ounces of falt. By repeated abftraction of brine, and replacing with water, we had the following feries:

Specific Gravity, Spectacles.

Series.		Brine.	Sp. Gr.	Oz. Salt in Cub. Ft.
Weight of brine,		1*ft*, 1698	1.061	228
After taking out	$\frac{1}{4}$,	2*d*, 1676	1.048	171
After taking out	$\frac{1}{3}$,	3*d*, 1653	1.033	114
After taking out	$\frac{1}{2}$,	4*th*, 1630	1.019	57
After taking out	$\frac{1}{2}$,	5*th*, 1616	1.010	$28\frac{1}{2}$
	$\frac{1}{2}$,	6*th*, 1610	1.0063	$14\frac{1}{4}$
	$\frac{1}{2}$,	7*th*, 1605	1.0038	$7\frac{1}{8}$

This feries is extremely regular, and the progrefs of denfity may be confidently deduced from it.

From the whole of this difquifition on the relation between the fpecific gravities of brines and the quantities of falt contained, we fee in general that it may be gueffed at, with a ufeful degree of precifion, from the denfity or fpecific gravity of faturated folutions. We therefore conclude with a lift of the fpecific gravities of feveral faturated folutions, made with great care by the bifhop of Landaff.—The temperature was 42°. The firft numerical column is the denfity of faturated brine, and the next is the denfity of a brine confifting of 12 parts (by weight) of water and one of falt. From this may be inferred the quantity in the faturated folution, and from this again may be inferred the quantity correfponding to inferior denfities.

Borax,	1.910	
Cor. Sublim.	1.037	
Alum,	1.033	
Glaub. falt,	1.054	1.029
Common falt,	1.198	1.059
Sal. cath. amar.	1.232	1.039
Sal ammon.	1.072	1.026
Vol. alk. mite,	1.087	
Nitre,	1.095	1.050
Rochelle falt,	1.114	
Blue vitriol,	1.150	1.052
Green vitriol,	1.157	1.043
White vitriol,	1.386	1.045
Pearl afh,	1.534	

SPECTACLES, in *Dioptrics*, a machine confifting of two lenfes fet in filver, horn, &c. to affift the defects of the organ of fight. Old people, and others who have flat eyes, ufe convex fpectacles, which caufe the rays of light to converge fo as to meet upon the retina: whereas myopes, or fhort-fighted people, ufe concave lenfes for fpectacles, which caufe the rays to diverge, and prevent their meeting ere they reach the retina. See Optics.

Some cafes of a peculiar nature have been met with where the fight receives no affiftance from the ufe of either convex or concave glaffes. To remedy this, the following method was contrived and fuccefsfully adopted. A man about fixty years of age having almoft entirely loft his fight, could fee nothing but a kind of thick mift with little black fpecks in it which feemed to float in the air. He could neither read, walk the ftreets, nor diftinguifh his friends who were moft familiar to him. In this deplorable fituation he procured fome fpectacles with large rings; and having taken out the glaffes, glasses, he substituted for them a conic tube of black Spanish copper. Looking through the large end of the cone he could read the smallest print placed at its other extremity. These tubes were of different lengths, and the openings at the end were also of different sizes; the smaller the aperture the better could he distinguish the smallest letters; the larger the aperture the more words or lines it commanded; and consequently the less occasion was there for moving the head and the hand in reading. Sometimes he used one eye, sometimes the other, alternately relieving each, for the rays of the two eyes could not unite upon the same object when thus separated by two opaque tubes. The thinner these tubes, the less troublesome are they. They must be totally blackened within so as to prevent all shining, and they should be made to lengthen or contract, and enlarge or reduce the aperture at pleasure.

When he placed convex glasses in these tubes, the letters indeed appeared larger, but not so clear and distinct as through the empty tube: he also found the tubes more convenient when not fixed in the spectacle rings; for when they hung loosely they could be raised or lowered with the hand, and one or both might be used as occasion required. It is almost needless to add, that the material of the tubes is of no importance, and that they may be made of iron or tin as well as of copper, provided the insides of them be sufficiently blackened *.

* Monthly Mag. 1795.

Ocular SPECTRA, images presented to the eye after removing them from a bright object, or closing them. When any one has long and attentively looked at a bright object, as at the setting sun, on closing his eyes, or removing them, an image, which resembles in form the object he was attending to, continues some time to be visible. This appearance in the eye we shall call the ocular spectrum of that object.

Phil. Trans. 1786.

These ocular spectra are of four kinds: 1st, Such as are owing to a less sensibility of a defined part of the retina, or spectra from defect of sensibility. 2d, Such as are owing to a greater sensibility of a defined part of the retina, or spectra from excess of sensibility. 3d, Such as resemble their object in its colour as well as form; which may be termed direct ocular spectra. 4th, Such as are of a colour contrary to that of their object, which may be termed reverse ocular spectra.

SPECTRE, an apparition, or something supposed to be preternaturally visible to human sight, whether the ghosts of dead men or beings superior to man.

A belief that supernatural beings sometimes make themselves visible, and that the dead sometimes revisit the living, has prevailed among most nations, especially in the rudest stages of society. It was common among the Jews, among the Greeks, and among the Romans, as we find from the Scriptures, and from the poems of Homer and Virgil. Celestial appearances were indeed so often exhibited to the Jews, that the origin of their belief is not difficult to be explained.—The Divine Being manifested himself to each of the patriarchs by some sensible sign, generally by a flame of fire, as he did to Moses. Under this semblance also did he appear to the Israelites during their abode in the desert, and after they obtained a settlement in the land of Canaan. Nor did they believe that heavenly beings alone assumed a sensible appearance: They believed that deceased men also sometimes revisited this world. When Saul went to consult the witch at Endor, he asked her to bring up the person whom he should name unto her; a proof that he considered his demand as easy to be performed, and therefore that he probably acted under the influence of popular opinion. The same opinions had been generally entertained at a much earlier period; for necromancy and witchcraft, the arts by which the dead were supposed to be raised, had been prohibited while the Israelites were in the wilderness, and yet untainted with the vices of the Canaanites. They must therefore have derived them from Egypt, the cradle of superstition, as well as of the arts and sciences.

Among the Greeks and Romans the apparition of spectres was generally believed. On innumerable occasions the gods are said to have discovered themselves to the eyes of mortals, to have held conferences, and to have interposed their aid. The ghosts of the dead, too, are said to have appeared. When Æneas, amidst the distraction and confusion of his mind in flying from the destruction of Troy, had lost his wife by the way, he returned in search of her. Her shade appeared to him (for she herself had been slain) with the same aspect as before, but her figure was larger. She endeavoured to assuage the grief of her unhappy husband, by ascribing her death to the appointment of the gods, and by foretelling the illustrious honours which yet awaited him. But when Æneas attempted to clasp her in his arms, the phantom immediately vanished into air. From this story we may observe, that the ancients believed that the umbræ or shades, retained nearly the same appearance after death as before; that they had so far the resemblance of a body as to be visible; that they could think and speak as formerly, but could not be touched. This description applies equally well to those shades which had passed the river Styx, and taken up their residence in the infernal regions. Such were the shades of Dido, of Deiphobus, and all those which Æneas met with in his journey through the subterraneous world.

It appears from the writings of modern travellers who have visited rude and savage nations, that the belief of spectres is no less common among them. Mr Bruce tells us, that the priest of the Nile affirmed, that he had more than once seen the spirit of the river in the form of an old man with a white beard. Among the Mahometans the doctrine of spectres seems to be reduced to a regular system, by the accounts which they give of genii. Whoever has read the Arabian Nights Entertainments must have furnished his memory with a thousand instances of this kind. Their opinions concerning genii seem to be a corrupted mixture of the doctrines of the Jews and ancient Persians. In Christian countries, too, notwithstanding the additional light which their religion has spread, and the great improvement in the sciences to which it has been subservient, the belief of ghosts and apparitions is very general, especially among the lower ranks. They believe that evil spirits sometimes make their appearance in order to terrify wicked men, especially those who have committed murder.—They suppose that the spirits of dead men assume a corporeal appearance, hover about church-yards and the houses of the deceased, or haunt the places where murders have been committed. (See Ghost.) In some places it is believed that beings have been seen bearing a perfect resemblance to men alive. In the Highlands of Scotland, what is called the second sight is still believed

lieved by many (see *SECOND Sight*); viz. that future events are foretold by certain individuals by means of spectral representation.

So general has the belief of spectres been, that this circumstance alone may be thought by some sufficient to prove that it must have its foundation in human nature, or must rest upon rational evidence. When any doctrine has been universally received by all nations, by generations living several thousand years from one another, and by people in all the different stages of society, there is certainly the strongest presumption to conclude that such a doctrine has its foundation in reason and in truth. In this way we argue in favour of the existence of a God, concerning moral distinction, and the doctrine of a future state: and certainly so far we argue well. But if the same argument be applied to idolatry, to sacrifices, or to apparitions, we shall find that it is applied improperly. Idolatry was very general among ancient nations; so was the offering of sacrifices, so was polytheism: but they were by no means universal. Should we allow, for the sake of shortening the argument, that all ancient nations were polytheists and idolaters, and presented oblations to their imaginary deities, all that could be concluded from this concession is, that they fell into these mistakes from their ignorance and from the rude state of society, from which their imperfect knowledge of theology and moral philosophy was never able to rescue them. These erroneous notions fled before the brightness of the Christian system; while the doctrines of the existence of God, of moral distinction, and of a future state, have been more thoroughly confirmed and ascertained. The same thing may be said of the belief of spectres. However generally it has been adopted in the first stages of society, or by civilized nations who had made but little progress in the study of divine things, it has been rejected, we may say invariably, wherever theology and philosophy have gone hand in hand.

As all popular and long established opinions are objects of curiosity and research for the philosopher, we think the belief of spectres worthy of some attention even in this light. It will therefore, we hope, give some satisfaction to the philosophical reader to see a short account of the sources or principles from which this belief is derived. But as the belief of spectres is connected with other opinions which appear to us highly injurious to religion; opinions which have been supported by many learned men, and which are still believed by some men of literary education—it will also be proper, in the first place, to consider the evidence on which this belief rests, in which we must consider both their probability and credibility.

In the present investigation we mean to set aside altogether the celestial appearances recorded in Scripture, as being founded on unquestionable evidence, and perfectly agreeable to those rules by which the Deity acts in the usual course of his Providence. The Israelites, during the existence of their state, were immediately under the authority of God, not only as the moral governor of the world, but as the king of Israel. In the infancy of the world, while men were rude and unenlightened, and entirely under the influence of idolatry, many revelations were necessary to preserve in their minds pure ideas of the nature of God, and of the worship due to Him. They were necessary also to pave the way for that illustrious dispensation which the Lord Jesus came from Heaven to diffuse over the world. Every celestial appearance recorded in Scripture was exhibited for some wise and important purpose, which must be apparent to every person who considers these appearances with attention. But when the Scriptures were written and published, and the Christian religion fully established, revelation ceased, and miracles and heavenly messages were no longer requisite. What credit then ought we to give to those marvellous stories related in ancient authors concerning prodigies in the heavens, and the apparition of angels both good and bad?

It is not pretended that any of those prodigies and appearances were exhibited for purposes equally great and important with those which are described in Scripture: And can we suppose that the all-wise Governor of the world would permit his angels to render themselves visible to the eye of man for no purpose at all, or for a purpose which might have been equally well accomplished without their interposition? Would this be consistent with perfect wisdom, or would it be consistent even with the excellence and superiority of understanding which we are taught to ascribe to these elevated beings? The whole will of God is revealed to us in the Scriptures; what further use for the visible interposition of angels? It may be objected, Are they not all ministering spirits, sent forth to minister for them who shall be heirs of salvation *? We answer, That angels may animate and support good men by an invisible interposition. But the Apostle is not speaking of celestial spirits. The word αγγελος signifies "a messenger;" and in Scripture often refers to men. In the passage which we are now reviewing it certainly is applied with much more propriety to men than to angels: for the Apostle is stating a comparison between *the Prophets*, by whom God, at sundry times and in divers manners, spake in time past to the fathers, and *the Son*, by whom he hath spoken in these last days.

* Heb. i. 14.

And if God has given no commission to his angels to deliver to men since the publication of the Christian religion, is there any probability that he would give any commission or any licence to evil spirits? It will be said, that this doctrine is clearly taught in the New Testament, in these words, "The devil goeth about as a roaring lion seeking whom he may devour." We will not avail ourselves of the interpretation of some, who say that the word *devil*, which in the Greek language signifies an *adversary*, or *slanderer*, refers here to some human being, who was a violent enemy of the Christians. All that can be deduced from these words, upon the supposition that they refer to a malignant spirit, is merely that he goeth about seducing men to vice. But it is not by assuming a hideous form, and presenting himself to the midnight traveller, that such a purpose is to be accomplished. A spirit may probably have direct access to our minds without the intervention of any thing corporeal; and by exciting our passions may plunge us into vice, which is the only object such a being is supposed to have in view. None of the marvellous stories which we have heard concerning the apparition of evil spirits lead us to conclude that they appear to entice men to commit crimes. We never heard of any evil spirit that required men to steal, to perpetrate robbery or murder. They only appeared to terrify some crazy timorous individuals, who have whims and fancies

Spectre. enow of their own to agitate their minds, though no preternatural vision should ever appear to them. It is not consistent, therefore, with the character of God, and what he has revealed to us of his will, to believe that he would commission good angels, or permit evil angels, to appear to men since the propagation of the gospel, or indeed at any former period of the world, unless some great and mighty purpose was to be fulfilled. It is not consistent with what we know of the nature of good or bad angels to suppose, that though permission were granted them occasionally to show themselves to men, that they would appear in that way which story-tellers describe.

It is equally improbable that the spirits of the dead who have removed from this world should again be permitted to visit it. At death men undergo as great, perhaps a greater change, than when they came first into the light of the sun. Is it not therefore as improbable that a man should return in a visible corporeal form after death, as that, after having arrived at manhood, he should return to the state in which he was before his birth? Such changes as these are evidently made permanent by the invariable laws of nature. But suppose it were possible, for what purpose should they return? To describe to us what is passing in the other world, to animate us to virtue, by informing us of the rewards which there await the good; or to alarm us, by describing the punishment of the wicked. These seem important reasons. But Divine Providence has wisely thrown a veil over futurity. We know every thing of the other world from the scripture which it is proper for us at present to know. And as to incentives to virtue, we are already blessed with a number sufficiently great and powerful for moral beings, who are to act from rational motives, and not from compulsion. "He that will not hear Moses and the prophets, will not be persuaded though one rose from the dead."

There is one strong objection against the probability of spectres, which is sufficient to prove that they are not intelligent creatures; or at least that they possess so small a degree of intelligence, that they are unqualified to act with prudence, to propose any end to themselves, or use the proper means to accomplish that end. Ghosts often appear in order to discover some crime that has been committed: but they never appear to a magistrate, or person in authority, but to some illiterate clown, who happens to live near the place where the crime was perpetrated; to some person who has no connection with the affair at all, and who in general is the most improper in the world for making the discovery. For instance, in Glanville's *Saducismus triumphatus* (a book written in the last century by a chaplain of Charles II. in support of the common opinions respecting witchcraft and apparitions), we have the following story: James Haddock, a farmer, was married to Elenor Welsh, by whom he had a son. After the death of Haddock, his wife married one Davis; and both agreed to defraud the son by the former marriage of a lease bequeathed to him by his father. Upon this the ghost of Haddock appeared to one Francis Taverner the servant of Lord Chichester, and desired him to go to Elenor Welsh, and to inform her that it was the will of her former husband that their son should enjoy the lease. Taverner did not at first execute this commission; but he was continually haunted by the apparition in the most hideous shapes, which even threatened to tear him in pieces, till at last he delivered the message. Now, had this spectre had the least common sense, it would have appeared first to Elenor Welsh and her husband Davis, and frightened them into compliance at once, and not have kept poor Taverner in such constant disquietude, who had no concern in the matter.

Another very odd circumstance respecting apparitions in general must not be omitted, which is, that they have no power to speak till they are addressed. In the 27th of Glanville's Relations we read of an old woman that appeared often to David Hunter, a neat-herd, at the house of the bishop of Down and Conners. Whenever she appeared, he found himself obliged to follow her; and for three quarters of a year poor David spent the whole of almost every night in scampering up and down through the woods after this old woman. How long this extraordinary employment might have continued, it is impossible to guess, had not David's violent fatigue made him one night exclaim, "Lord bless me! would I were dead!—shall I never be delivered from this misery!" On which the phantom replied, "Lord bless me too! It was happy you spoke first, for till then I had no power to speak, though I have followed you so long." Then she gave him a message to her two sons, though David told her he remembered nothing about her. David, it seems, neglected to deliver the message; at which the old beldam was so much provoked, that she returned and hit him a hearty blow on the shoulder, which made him cry out, and then speak to her. Now if she could not speak till David addressed her, why might she not have applied this oratorial medicine the first time she appeared to him? It would have saved both herself and him many a weary journey; and certainly David would much rather have had even half a dozen of blows from her choppy fists than have wanted so many nights sleep. To complete the story, we must add, that when David's wife found it impossible to keep him from following the troublesome visitor, she trudged after him, but never was gratified with a sight of the enchantress. David's little dog too was a dutiful attendant on his master during his pilgrimage.

It is remarked by Glanville, that ghosts are generally very eager to be gone. Indeed they are often so much so, that they do not stay to tell their errand. One would be induced from this, as well as the circumstances already mentioned, to think that they are the stupidest and dullest of the dead that assume the appearance of ghosts; unless we adopt the ingenious solution of Glanville, "that it is a very hard and painful thing for them to force their thin and tenuious bodies into a visible consistence; that their bodies must needs be exceedingly compressed; and that therefore they must be in haste to be delivered from the unnatural pressure."

With respect to the *evidence* in favour of spectres, if examined ever so slightly, it will be found very defective. They only appear to one person at a time; they are seen only in the night; they are visible only to ignorant, illiterate, and credulous persons, and never present themselves before men of education and learning.

That spectres only appear to one person at a time, even though there are more in company, is an objection against the credibility of their appearance quite insurmountable.

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mountable. How is it poffible that two men of eye-fight equally good, directing their eyes to the fame fpot, fhould not fee fo large an object as that of a man or woman at a fmall diftance equally well? Some will tell us that a mift is caft over the eyes of the one, while the view of the other is free from obftruction. But how is this to be proved? and befides, what purpofe would it ferve? Ghofts have feldom any fecrets to difclofe; they might be proclaimed to a multitude with as much propriety as confined to one perfon. Shall we be told, that the fpectre has the power of becoming vifible to fome, and of remaining invifible to others? This cannot be allowed without adopting opinions deftructive to revealed religion; for it would be a miracle: and we cannot be perfuaded, without evidence, that God would empower any inferior being to controul at pleafure the wife laws which he has ordained for governing the world. To him who is of a different opinion, we would recommend Farmer on Miracles; a book in which this queftion is fully examined.

Spectres appear only in the night. But why fhould they fhun the light of the fun? Thofe mifchievous ghofts that Glanville mentions might indeed have fome reafon to choofe midnight for the execution of their pranks, as they would be more eafily detected in open day. Such was the roguifh drummer that haunted Mr Mompeffon's houfe, who beat his drum all night, threw the old gentlewoman's clothes about the room, hid her Bible in the afhes, plucked the clothes off the bed, and amufed himfelf with toffing about Mr Mompeffon's fhoes. But why fhould a grave ferious ghoft appear at midnight? Might it not deliver its meffage with as much eafe and more fuccefs in the day-time? In the day-time it would not excite much fear; it would be liftened to therefore with more attention; and did it choofe to exhibit itfelf before a number of witneffes, its grievances would be more fpeedily redreffed, becaufe more perfons would intereft themfelves in feeing juftice done to the injured ghoft.

Spectres not only choofe the moft improper time, but the moft improper perfons. To render the teftimony of any perfon credible, he muft not only be a man of veracity, but he muft have fufficient ability to judge of the fubject to which he is to bear witnefs. It is not on the evidence of an ignorant illiterate perfon, who has more fancy and fear than judgement, that we are to reft our belief of what is fupernatural. It is alfo worthy of remark, that we have never heard of a ghoft appearing to any perfon who did not previoufly believe their exiftence. A man muft be prejudiced in favour of this opinion, or he will never fee a ghoft. But fenfible men know, that he who has been accuftomed to hear frightful ftories of ghofts and apparitions gliding through a churchyard, or haunting fome particular place, can fcarcely pafs through a churchyard, or haunted fpot without conjuring up in his imagination the hideous phantoms which he has been accuftomed to affociate with fuch places. Is it ftrange, then, that an ignorant man, with a mind uncultivated and uninformed, with all the prejudices of the nurfery about him, fhould imagine he fees ghofts in thofe places where he believes they hover, efpecially in the dead hour of midnight, when, with the flighteft aid of the imagination, a cow may be turned into a monftrous phantom, and the reflection of the beams of the moon from a little water be converted into a ghoft with a winding-fheet? But why fhould apparitions fhun men of underftanding and learning? Why fhould learning be formidable to them (A)? It was not fo with the celeftial meffengers mentioned in the Scriptures: they appeared to the patriarchs and prophets; and the miracles there recorded were performed in the moft public places, before the eyes of Rabbies, of Scribes, and Pharifees. Indeed this circumftance is fufficient to deftroy the evidence of fpectres. They have never been feen by any but men of weak or diftempered minds, or by men who have previoufly believed in them.

Having now confidered the evidence on which the belief of fpectres refts, we will endeavour to give fome account of the foundation of it. To trace an opinion that has prevailed fo generally in the world to its fource, is a labour not unworthy of the philofopher, even though the opinion be falfe. It is always gratifying to detect the caufes of error: it is no lefs ufeful; for in order to refute error, it is often fufficient to point out the fources from which it has fprung. To reach the origin of the belief of fpectres is not more difficult than to account for idolatry or polytheifm. In the infant ftate of the intellectual powers every thing is confidered as poffeffing life and intelligence. The child beats the ftool

(A) The celebrated hiftorian De Thou had a very fingular adventure at Saumur, in the year 1598. One night, having retired to reft very much fatigued, while he was enjoying a found fleep, he felt a very extraordinary weight upon his feet, which, having made him turn fuddenly, fell down and awakened him. At firft he imagined that it had been only a dream, but hearing foon after fome noife in his chamber, he drew afide the curtains and faw, by help of the moon, which at that time fhone very bright, a large white figure walking up and down, and at the fame time obferved upon a chair fome rags, which he thought belonged to thieves who had come to rob him. The figure then approaching his bed, he had the courage to afk it what it was. "I am (faid it) the Queen of Heaven." Had fuch a figure appeared to any credulous ignorant man in the dead of night, and made fuch a fpeech, would he not have trembled with fear, and have frightened the whole neighbourhood with a marvellous defcription of it? But De Thou had too much underftanding to be fo impofed upon. Upon hearing the words which dropped from the figure, he immediately concluded that it was fome mad woman, got up, called his fervants, and ordered them to turn her out of doors; after which he returned to bed and fell afleep. Next morning he found that he had not been deceived in his conjecture, and that having forgot to fhut his door, this female figure had efcaped from her keepers, and entered his apartment. The brave Schomberg, to whom De Thou related his adventure fome days after, confeffed that in fuch a cafe he would not have fhown fo much courage. The king alfo, who was informed of it by Schomberg, made the fame acknowledgement.

ſtool over which he has fallen with the ſame paſſion that he would treat his companion: The young girl talks to her doll as if it underſtood her: The ſavages aſcribe every change which they obſerve on the face of nature to the action of ſome animated being. As knowledge advances, they ſingle out thoſe beings which ſeem to produce the moſt ſtriking effects, arrange them into ſome kind of order, and divide the government of the world among them. Unable, at the ſame time, to conceive any notion of a pure ſpirit, they imagine thoſe divinities are corporeal beings. This is the foundation of idolatry. The belief of ſpectres is but another ſtep. That theſe animated corporeal beings, to whom they addreſs their prayers, and who preſide over the world, ſhould on particular occaſions diſplay themſelves to the human eye, is what they muſt be previouſly diſpoſed to expect. Hence the numberleſs appearances of the heathen gods, of the Perſian and Mahometan genii. The belief of ghoſts may be eaſily deduced from the opinions entertained reſpecting a future ſtate. Theſe opinions are founded on that eſſential doctrine of natural religion, that there is another world in which men ſhall exiſt when death has removed them hence. This doctrine has been univerſally received both by ſavage and civilized nations; but, as might be expected, men have formed very different ſentiments concerning the nature of a future ſtate, of the ſituation and employments of departed ſpirits, according to the degree of knowledge which they poſſeſſed. But the general opinion in ancient and rude nations was, that departed ſpirits retained the ſame external appearance, the ſame paſſions and principles as before. Nothing therefore was more natural than the opinion, that they might occaſionally reviſit this world, from an anxious deſire to alleviate the ſufferings of thoſe beloved friends and relations whom they had left behind them, or to communicate from the unſeen world what might be important to their welfare. Upon ſuch an errand did Creüſa appear to Æneas. The apparition of the ghoſts of murderers is eaſily explained upon the ſame general principles. The remorſe and horror of mind which the murderer feels are ſuppoſed to haunt him in the other world, and to render his ſituation there intolerable (eſpecially if the murder was never detected and puniſhed), till he return and give information againſt himſelf. In this way, then, we think it highly probable the belief of ſpectres has originated. But many other cauſes concur to confirm and propagate this belief. Theſe are, imperfect viſion united with fear, dreams, opium, diſeaſes, drunkenneſs, and opium.

1. Indiſtinct viſion is one ſource of apparitions, eſpecially when the mind is under the influence of fear. It is well known, that the ſenſe of ſeeing conveys no idea of diſtance till improved by experience and obſervation; and how we come at length to diſtinguiſh objects at a diſtance from thoſe that are near, has been explained in another place (ſee METAPHYSICS, N° 50.).

In the daytime we ſeldom commit miſtakes, becauſe we know the object at which we look; but at night, when we ſee objects obſcurely, and know not what they are, we have no diſtinct idea either of their diſtances or of their magnitude. We may miſtake a buſh that is near us for a tree at a diſtance; or if the imagination be under the influence of fear, it will eaſily convert it into a gigantic figure. "It is generally aſſerted (ſays Buffon) that theſe figures exiſt only in the imagination; yet they may have a real exiſtence in the eye; for whenever we have no other mode of judging of an unknown object but by the angle it forms in the eye, its magnitude will uniformly increaſe in proportion to its propinquity. If it appears, when at the diſtance of 20 or 30 paces, to be only a few feet high, its height, when within two or three feet of the eye, will be many fathoms. An object of this kind muſt naturally excite terror and aſtoniſhment in the ſpectator, till he approaches and recogniſes it by actual feeling; for the moment a man knows an object, the gigantic appearance it aſſumed in the eye inſtantly diminiſhes, and its apparent magnitude is reduced to its real dimenſions. But if, inſtead of approaching ſuch an object, the ſpectator flies from it, he can have no other idea of it but from the image which it formed in his eye; and, in this caſe, he may affirm with truth that he ſaw an object terrible in its aſpect, and enormous in its ſize. Thus the notions concerning ſpectres is founded in nature, and depend not, as ſome philoſophers affirm, upon the imagination alone."

In addition to theſe obſervations of Buffon, we may take notice, that objects are always magnified in a fog; ſo that when a fog happens in the night-time, objects may be magnified to an enormous ſize. But, at any rate, whether there be fog in the night or not, there is ſuch a great analogy between darkneſs and a fog, that if the latter deceive us with reſpect to the ſize of objects, the former will alſo deceive us. The writer of this article was paſſing the frith of Forth at Queensferry, near Edinburgh, one morning which was extremely foggy. Though the water be only two miles broad, the boat did not get within ſight of the ſouthern ſhore till it approached very near it. He then ſaw to his great ſurpriſe a large perpendicular rock, where he knew the ſhore was low and almoſt flat. As the boat advanced a little nearer, the rock ſeemed to ſplit perpendicularly into portions, which ſeparated at a little diſtance from one another. He next ſaw theſe perpendicular diviſions move; and upon approaching a little nearer, found it was a number of people ſtanding on the beach, waiting the arrival of the ferry-boat.

2. Dreams are another fertile ſource of apparitions. It is well known to every perſon, that while the mind is under the influence of a dream it conſiders it as much a reality as it does any particular action while awake. Now if a perſon of a weak ſuperſtitious mind ſhould have a very lively dream, which intereſts his paſſions, particularly the paſſion of fear, it may make ſo deep an impreſſion, that he may be firmly convinced that he has actually ſeen with his eyes what has only paſſed before his imagination (ſee APPARITION) (B). We ſhall here tell a ſtory, by way of illuſtration, which we have

(B) When the thoughts are much troubled, and when a perſon ſleeps without the circumſtances of going to bed, or putting off his clothes, as when he nods in his chair, it is very difficult, as Hobbes remarks, to diſtinguiſh a dream from a reality. On the contrary, he that compoſes himſelf to ſleep, in caſe of any uncouth or abſurd fancy, eaſily ſuſpects it to have been a dream.—*Leviathan*, par. i. c. 1.

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have received on unquestionable authority. An East India captain had an honest faithful servant named *John*, for whom he had a great regard. John died, if we recollect right, on a voyage from England to the East Indies during a French war. As the ship approached the place of its destination the captain had a dream, in which John appeared to him, and earnestly besought him not to sail to the port for which he was bound, as it was in the hands of the French. The captain, though not addicted to superstition, thought it prudent to follow this admonition; and after landing at a different port, he was informed that the place to which he had intended to steer was, according to the information of the dream, captured by the French. On the voyage home, the captain had a second dream, in which John again appeared to him, and gave him notice that he should soon die, and that the ship should be taken in the mouth of the Channel by the French. Next morning the captain called his first mate, told him his dream, which he believed was prophetic, and delivered his papers, that he might take proper care of them after his decease. Every thing happened exactly as the dream had foretold; the captain died, and the vessel was taken by a French man of war in the mouth of the Channel. This dream, wonderful as it appears, is easily explained. In the voyage out to India, nothing was more natural than that the captain should sometimes be thinking, that amidst the various chances of war, the port to which he was bound might be taken; perhaps it was a place of consequence, which the French might be eager to possess. The captain being accustomed to revolve these thoughts in the day-time, they would naturally return at night; the regret which he felt for the loss of a faithful servant might mingle with his apprehensions, and thus produce the dream. Perhaps the advice was such as John would have given had he been alive. It is equally easy to explain the cause of the dream in the passage home. The captain, we are told, was very ill, and thought himself dying, at the very time he had the second dream, and therefore did not expect to reach England. This part of the dream, then, was only his own thoughts, delivered by his servant. As to the other part, that his ship should be taken in the mouth of the Channel, it may be thought unaccountable how the very place should be foreseen. But we must recollect, that the mouth of the Channel, being over against the coast of France, was by far the most dangerous place in the whole passage; and that, therefore, the captain had more reason to be afraid of losing his ship there than in any other place. The use which we mean to make of this story is this: Had the captain been a man of a weak mind, he would certainly have considered the dream as a reality, and believed that, instead of having dreamed of the things on which his imagination had dwelt, he had actually seen his servant return from the dead, and heard him deliver the message. But, on the other hand, the captain, though he believed the dream was prophetic, mentioned it without any signs of fear; and no man of courage and reflection ever sees an apparition. This sight is reserved for the weak, the timid, and the superstitious. Of this many instances might be mentioned.

3. Spectres are also sometimes occasioned by opium. Gassendi the philosopher found a number of people going to put a man to death for having intercourse with the devil; a crime which the poor wretch readily acknowledged. Gassendi begged of the people that they would permit him first to examine the wizard before putting him to death. They did so; and Gassendi, upon examination, found that the man firmly believed himself guilty of this impossible crime. He even offered to Gassendi to introduce him to the devil. The philosopher agreed; and when midnight came, the man gave him a pill, which he said it was necessary to swallow before setting off. Gassendi took the pill, but gave it to his dog. The man having swallowed his, fell into a profound sleep; during which he seemed much agitated by dreams. The dog was affected in a similar manner. When the man awoke, he congratulated Gassendi on the favourable reception he had met with from his sable highness. It was with difficulty Gassendi convinced him that the whole was a dream, the effect of soporific medicines, and that he had never stirred from one spot during the whole night.

Spectre.

4. That diseases, especially the night-mare, the hypochondria, hysteric passion, and madness, are another source of spectres, we have the strongest reason to affirm. Persons subject to the night-mare often imagine that they see spectres. This is still more the case with hypochondriac and hysteric persons, and those who are in any degree deranged in their intellects. A fact which fell within the observation of the writer of this article will both prove and illustrate this assertion. In a village in one of the midland counties of Scotland, lived a widow distinguished among her neighbours for decency of manners, integrity, and respect for religion. She affirmed, that for several nights together she had heard a supernatural voice exclaiming aloud, *Murder! murder!* This was immediately reported through the neighbourhood; all were alarmed, and looked around them with solicitude for the detection of the murder which they supposed to have been committed; and it was not long till a discovery seemed actually to be made. It was reported, that a gentleman, who had relations at no great distance, and had been residing in the West Indies, had lately arrived with a considerable fortune; that he had lodged in an inn about three miles off; and that he had afterwards been seen entering a house in the village where the widow lived, from which he had never returned. It was next affirmed, that a tradesman passing the churchyard about twelve at midnight had seen four men carry a dead corpse into that cemetery. These three facts being joined together seemed perfectly to agree and to confirm one another, and all believed some horrible murder had been committed. The relations of the gentleman thought they were called upon to make inquiry into the truth of these allegations: they accordingly came first to the churchyard, where, in company with the sexton, they examined all the graves with great care, in order to discover whether any of them had been lately dug, or had the appearance of containing more than one coffin. But this search was to no purpose, for no alteration had been made upon the graves. It was next reported that the murdered man had been buried in a plantation about a mile distant from the village. As the alarm was now very general, a number of the inhabitants proposed of their own accord to explore it. They accordingly spread themselves over the wood, and searched it with care, but no grave nor new dug earth was found. The writer of this article, who was then a boy at school, was along with them. The matter

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ter did not rest here: The person who was said to have seen four men carry a dead corpse into the churchyard at midnight was summoned to appear before a meeting of the justices of the peace. Upon examination he denied any knowledge of the affair, but referred the court to another person from whom he had received his information. This person was examined, and the result was the same as the former. In short, one person had heard it from another, who had received it from a third, who had heard it from a fourth; but it had received a little embellishment from every person who repeated it. It turned out to be the same with Smollet's story of the three black crows, which some body was said to have vomited.

Upon inquiry at the inn where the West Indian gentleman had lodged, no such gentleman had been seen there. It was found afterwards he had never left the West Indies. Still, however, the veracity of the widow was not disputed; and some dark and secret transaction was suspected. But the whole affair was at length explained by discovering that she was somewhat deranged by melancholy. And the cries which she had at first imagined she had heard were afterwards imitated by some roguish person, who was highly amused with spreading terror among the credulous.

5. Drunkenness also has the power of creating spectres. Its natural effect in most cases is to derange the understanding, to throw it off its guard, and to give full scope to that passion which has a natural disposition to gain an ascendancy; and sometimes it excites passions which scarcely seem to exist at any other time. It makes some men licentious, some furious, some all benevolence and kindness, some from being cowards it renders undaunted heroes. It seldom, if ever, excites fear; and therefore it may be thought strange that men should imagine they see ghosts when intoxicated. But it must be remarked, that the ghosts which the drunkard sees, he sees not with the same alarm and terror as men who are sober. He is not afraid of them. He has the courage to converse with them, and even to fight with them, if they give him provocation. A man returning home intoxicated, affirmed that he had met with the devil; and that after a severe encounter he had vanquished him and brought him to the ground, to which he had nailed him fast by driving his staff through his body. Next morning the staff was found stuck with great violence into a heap of turfs!

6. Many apparitions of spectres have no other origin than the artifices of the waggish or self-interested. Dr Plot, in his Natural History of Oxfordshire, relates a marvellous story, which will illustrate this assertion. Soon after the murder of King Charles I. a commission was appointed to survey the king's house at Woodstock, with the manor, park, woods, and other demesnes to that manor belonging; and one Collins, under a feigned name, hired himself as secretary to the commissioners, who, upon the 13th of October 1649. met, and took up their residence in the king's own rooms. His majesty's bed-chamber they made their kitchen, the council hall their pantry, and the presence-chamber was the place where they sat for the dispatch of business. His majesty's dining-room they made their wood yard, and stored it with the wood of the famous royal-oak from the High Park, which, that nothing might be left with the name of king about it, they had dug up by the roots, and split and bundled up into faggots for their firing. Things being thus prepared, they sat on the 16th of the same month for the dispatch of business; and in the midst of their first debate there entered a large black dog (as they thought, which made a dreadful howling, overturned two or three of their chairs, and then crept under a bed and vanished. This gave them the greater surprise, as the doors were kept constantly locked, so that no real dog could get in or out. The next day their surprise was increased, when sitting at dinner in a lower room, they heard plainly the noise of persons walking over their heads, though they well knew the doors were all locked, and there could be no body there. Presently after they heard also all the wood of the king's oak brought by parcels from the dining-room, and thrown with great violence into the presence chamber; as also all the chairs, stools, tables, and other furniture, forcibly hurried about the room; their papers, containing the minutes of their transactions were torn, and the ink-glass broken. When all this noise had ceased, Giles Sharp, their secretary, proposed to enter first into these rooms; and in presence of the commissioners, from whom he received the key, he opened the doors, and found the wood spread about the room, the chairs tossed about and broken, the papers torn, the ink-glass broken (as has been said), but not the least track of any human creature, nor the least reason to suspect one, as the doors were all fast, and the keys in the custody of the commissioners. It was therefore unanimously agreed, that the power who did this mischief must have entered the room at the key-hole. The night following, Sharp the secretary, with two of the commissioners servants, as they were in bed in the same room, which room was contiguous to that where the commissioners lay, had their bed's feet lifted up so much higher than their heads, that they expected to have their necks broken, and then they were let fall at once with so much violence as shook the whole house, and more than ever terrified the commissioners. On the night of the 19th, as all were in bed in the same room for greater safety, and lights burning by them, the candles in an instant went out with a sulphureous smell, and that moment many trenchers of wood were hurled about the room, which next morning were found to be the same their honours had eaten on the day before, which were all removed from the pantry, though not a lock was found opened in the whole house. The next night they fared still worse; the candles went out as before, the curtains of their honours beds were rattled to and fro with great violence; their honours received many cruel blows and bruises, by eight great pewter-dishes and a number of wooden trenchers being thrown on their beds, which being heaved off, were heard rolling about the room, though in the morning none of these were to be seen. This night likewise they were alarmed with the tumbling down of oaken billets about their beds, and other frightful noises; but all was clear in the morning, as if no such thing happened. The next night the keeper of the king's house and his dog lay in the commissioners room, and then they had no disturbance. But on the night of the 22d, though the dog lay in the room as before, yet the candles went out, a number of brick-bats fell from the chimney into the room, the dog howled piteously, their bed clothes were all stripped off, and their terror increased. On the

Spectre. 24th they thought all the wood of the king's oak was violently thrown down by their bed fides; they counted 64 billets that fell, and fome hit and fhook the beds in which they lay; but in the morning none were found there, nor had the door been opened where the billet wood was kept. The next night the candles were put out, the curtains rattled, and a dreadful crack like thunder was heard; and one of the fervants running in hafte, thinking his mafter was killed, found three dozen of trenchers laid fmoothly under the quilt by him. But all this was nothing to what fucceeded afterwards: The 29th, about midnight, the candles went out, fomething walked majeftically through the room, and opened and fhut the windows; great ftones were thrown violently into the room, fome of which fell on the beds, others on the floor; and at about a quarter after one a noife was heard as of forty cannon difcharged together, and again repeated at about eight minutes diftance. This alarmed and raifed all the neighbourhood, who coming into their honours room, gathered up the great ftones, fourfcore in number, and laid them by in the corner of a field, where, in Dr Plot's time, who reports this ftory, they were to be feen. This noife, like the difcharge of cannon, was heard through all the country for 16 miles round. During thefe noifes, which were heard in both rooms together, the commiffioners and their fervants gave one another over for loft, and cried out for help; and Giles Sharp, fnatching up a fword, had well nigh killed one of their honours, miftaking him for the fpirit, as he came in his fhirt from his own room to theirs. While they were together, the noife was continued, and part of the tiling of the houfe was ftript off, and all the windows of an upper room were taken away with it. On the 30th at midnight fomething walked into the chamber treading like a bear; it walked many times about, then threw the warming-pan violently on the floor; at the fame time a large quantity of broken glafs, accompanied with great ftones and horfes bones, came pouring into the room with uncommon force. Thefe were all found in the morning to the aftonifhment and terror of the commiffioners, who were yet determined to go on with their bufinefs. But on the firft of November the moft dreadful fcene of all enfued: Candles in every part of the room were lighted up, and a great fire made; at midnight, the candles all yet burning, a noife like the burfting of a cannon was heard in the room, and the burning billets were toffed about by it even into their honours beds; who called Giles and his companions to their relief, otherwife the houfe had been burnt to the ground; about an hour after the candles went out as ufual, the crack as if many cannon was heard, and many pailfuls of green ftinking water were thrown upon their honours beds; great ftones were alfo thrown in as before, the bed curtains and bedfteads torn and broken, the windows fhattered, and the whole neighbourhood alarmed with the moft dreadful noifes; nay, the very rabbitftealers that were abroad that night in the warren were fo terrified, that they fled for fear and left their ferrets behind them. One of their honours this night fpoke, and, *in the name of God, afked what it was, and why it difturbed them fo?* No anfwer was given to this; but the noife ceafed for a while, when the fpirit came again; and, as they all agreed, *brought with it feven devils worfe than itfelf.* One of the fervants now lighted a large candle, and fet it in the door-way between the two chambers, to fee what paffed; and as he watched it, he plainly faw a hoof ftriking the candle and candleftick into the middle of the room, and afterwards making three fcrapes over the fnuff, fcraped it out. Upon this the fame perfon was fo bold as to draw a fword; but he had fcarce got it out when he felt another invifible hand holding it too, and pulling it from him; and at length prevailing, ftruck him fo violently on the head with the pummel, that he fell down for dead with the blow. At this inftant was heard another burft like the difcharge of the broadfide of a fhip of war, and at about a minute or two's diftance each no lefs than 19 more fuch: thefe fhook the houfe fo violently, that they expected every moment it would fall upon their heads. The neighbours, on this, as has been faid, being all alarmed, flocked to the houfe in great numbers, and all joined in prayer and pfalm finging; during which the noife ftill continued in the other rooms, and the difcharge of cannons was heard as from without, though no vifible agent was feen to difcharge them. But what was the moft alarming of all, and put an end to their proceedings effectually, happened the next day as they were all at dinner, when a paper, in which they had figned a mutual agreement to referve a part of the premifes out of the general furvey, and afterwards to fhare it equally amongft themfelves, (which paper they had hid for the prefent under the earth in a pot in one corner of the room, and in which an orange-tree grew), was confumed in a wonderful manner, by the earth's taking fire with which the pot was filled, and burning violently with a blue fume, and an intolerable ftench; fo that they were all driven out of the houfe, to which they could never again be prevailed upon to return.

This wonderful contrivance was all the invention of the memorable Jofeph Collins of Oxford, otherwife called *Funny Joe*, who having hired himfelf as fecretary, under the name of *Giles Sharp*, by knowing the private traps belonging to the houfe, and the help of *pulvis fulminans* and other chemical preparations, and letting his fellow-fervants into the fcheme, carried on the deceit without difcovery to the very laft; infomuch that the Dr Plot, in his Natural Hiftory, relates the whole for fact, and concludes in this grave manner, "That though tricks have been often played in affairs of this kind, many of the things above related are not reconcileable with juggling; fuch as the loud noifes, beyond the power of man to make without fuch inftruments as were not there; the tearing and breaking the beds; the throwing about the fire; the hoof treading out the candle; and the ftriving for the fword, and the blow the man received from the pummel of it."

SPECTRE of the Broken, a fingular phenomenon obferved on the top of the *Broken*, one of the Hartz mountains in Hanover, of which M. Haue has given the following account. "After having been here (fays he) for the thirtieth time, and having procured information refpecting the above-mentioned atmofpheric phenomenon, I was at length, on the 23d of May 1797, fo fortunate as to have the pleafure of feeing it; and perhaps my defcription may afford fatisfaction to others who vifit the Broken through curiofity. The fun rofe about four o'clock, and, the atmofphere being quite ferene towards the eaft, his rays could pafs without any obftruction over the Heinrichfhöhe. In the fouth-weft, however, Spectre ‖ Speculum.

ever, towards Achtermannſhöhe, a briſk weſt wind carried before it thin tranſparent vapours, which were not yet condenſed into thick heavy clouds.

"About a quarter paſt four I went towards the inn, and looked round to ſee whether the atmoſphere would permit me to have a free proſpect to the ſouth-weſt; when I obſerved, at a very great diſtance towards Achtermannſhöhe, a human figure of a monſtrous ſize. A violent guſt of wind having almoſt carried away my hat, I clapped my hand to it by moving my arm towards my head, and the coloſſal figure did the ſame.

"The pleaſure which I felt on this diſcovery can hardly be deſcribed; for I had already walked many a weary ſtep in the hopes of ſeeing this ſhadowy image, without being able to gratify my curioſity. I immediately made another movement by bending my body, and the coloſſal figure before me repeated it. I was deſirous of doing the ſame thing once more—but my coloſſus had vaniſhed. I remained in the ſame poſition, waiting to ſee whether it would return; and in a few minutes it again made its appearance on the Achtermannſhöhe. I paid my reſpects to it a ſecond time, and it did the ſame to me. I then called the landlord of the Broken; and having both taken the ſame poſition which I had taken alone, we looked towards the Achtermannſhöhe, but ſaw nothing. We had not, however, ſtood long, when two ſuch coloſſal figures were formed over the above eminence, which repeated our compliments by bending their bodies as we did; after which they vaniſhed. We retained our poſition; kept our eyes fixed on the ſame ſpot, and in a little the two figures again ſtood before us, and were joined by a third. Every movement that we made by bending our bodies theſe figures imitated—but with this difference, that the phenomenon was ſometimes weak and faint, ſometimes ſtrong and well defined. Having thus had an opportunity of diſcovering the whole ſecret of this phenomenon, I can give the following information to ſuch of my readers as may be deſirous of ſeeing it themſelves. When the riſing ſun, and according to analogy the caſe will be the ſame at the ſetting ſun, throws his rays over the Broken upon the body of a man ſtanding oppoſite to fine light clouds floating around or hovering paſt him, he needs only fix his eyes ſtedfaſtly upon them, and, in all probability, he will ſee the ſingular ſpectacle of his own ſhadow extending to the length of five or ſix hundred feet, at the diſtance of about two miles before him."

SPECULARIS Lapis, compoſed of large plates of extreme thinneſs. (See Talc, Mineralogy *Index*). The white variety with large and broad leaves, commonly called *iſinglaſs and Muſcovy glaſs*, is imported in great quantities; the miniature-painters cover their pictures with it; the lantern-makers ſometimes uſe it inſtead of horn; and minute objects are uſually preſerved between two plates of it, for examination by the microſcope.

SPECULATIVE, ſomething relating to the theory of ſome art or ſcience, in contradiſtinction to practical.

SPECULUM for reflecting teleſcopes, is made of a kind of white copper conſiſting of 32 parts fine red copper, one of braſs, 15 of grain-tin, and three of white arſenic. The proceſs given by the late J. Edwards, who was rewarded by the Board of Longitude for diſcloſing it to the public, was publiſhed in the Nautical Almanack for 1787, and is as follows: Melt the copper in a large crucible, employing ſome black flux, compoſed of two parts of tartar and one of nitre: when melted, add to it the braſs and the ſilver. Let the pure tin be melted in another crucible, alſo with ſome black flux. Take them both from the fire, and pour the melted tin into the fuſed maſs in the large crucible. Stir the whole well with a dry ſpatula of birch, and pour off the fuſed metal immediately into a large quantity of cold water. The ſudden chill of the water will cauſe the fluid metal to divide into an infinite number of ſmall particles, which will cool inſtantly.

Speculum. *Cronſtedt's Mineralogy*, vol. ii. p. 712.

If the copper be completely ſaturated, the fracture of one piece of this mixed metal will appear bright, and of a gloſſy look, reſembling the face of pure quickſilver. But if it is of a brown reddiſh colour, it wants a little more tin. To aſcertain the required proportion, melt a ſmall quantity, known by weight, of the mixed metal, with a known very ſmall part of tin; and, if neceſſary, repeat the trial with different doſes, till the fracture of the new mixture looks as already deſcribed. Having now aſcertained the neceſſary addition of tin that is required, proceed to the laſt melting of the whole metal, together with the additional proportional doſe of tin; fuſe the whole, obſerving the ſame cautions as before; and you will find that the mixture will melt with a much leſs heat than that for the firſt fuſion. Have ready as many ounces of white arſenic in coarſe powder as there are pounds in the weight of the metal; wrap up the arſenic in a ſmall paper, and put it, with a pair of tongs, into the crucible; ſtir it well with the ſpatula, retaining the breath to avoid the arſenical fumes or vapours (which however are not found to be hurtful to the lungs) till they diſappear; take the crucible off the fire, clear away the droſs from the top of the metal, pour in about one ounce of powdered roſin, with as much nitre, in order to give the metal a clean ſurface, and pour out the metal into the moulded flaſks.

The ſpeculum ſhould be moulded with the concave ſurface downwards, and many ſmall holes ſhould be made through the ſand upwards, to diſcharge the air. The moulding ſand from Highgate near London, uſed by the founders, is as good as any for caſting theſe metallic mirrors. The caſt metal ſhould be taken out from the ſand of the flaſks whilſt it is hot, or elſe it may happen to crack if left to cool within. See Telescope.

But in addition to what has now been ſaid, we muſt notice ſome other information relative to the grinding, poliſhing, and other important circumſtances connected with the method of preparing the moſt perfect ſpecula for teleſcopes. The metal being taken out of the flaſk, as already noticed, and this ſhould be done as ſoon as it has become ſolid, and while it is yet red hot, care muſt be taken to keep the face downwards to prevent it from ſinking. Holding it in that poſition by the git, force out the ſand from the hole in the middle of the mirror with a piece of wood or iron, and place the ſpeculum in an iron pot, with a large quantity of hot aſhes or ſmall coals, ſo as to bury the ſpeculum in them a ſufficient depth. If the ſand is not forced out of the hole in the manner above directed, the metal, by ſinking as it cools, will

Speculum. will embrace the sand in the middle of the speculum so tight, as to cause it to crack before it becomes entirely cold. And if the metal be not taken out of the sand, and put in a pot with hot ashes or coals to anneal it, the moisture from the sand will always break the metal. Let the speculum remain in the ashes till the whole is become quite cold. The git may be easily taken off by marking it round with a common fine half round file, and giving it then a gentle blow. The metal is then to be rough ground and figured.

But before we proceed to describe that process, it may be proper to give an account of another composition for the speculum of a reflecting telescope, which has been employed with great success, by Rochon director of the marine observatory at Brest. Of this composition the principal ingredient is platina; which, in grains, must be purified in a strong fire by means of nitre and the salt of glass, or that flux which in the English glass-houses is called by the workmen *sandifer*. To the platina, when purified, add the eighth part of the metal employed in the composition of common specula; for tin without red copper would not produce a good effect. This mixture is then to be exposed to the most violent heat, which must be still excited by the oxygen gas that disengages itself from nitre when thrown into the fire. One melting would be insufficient: five or six are requisite to bring the mixture to perfection. It is necessary that the metal should be in a state of complete fusion at the moment when it is poured into the mould. By this process I have been enabled (says the author) to construct a telescope with platina, which magnifies the diameters of objects five hundred times, with a degree of clearness and distinctness requisite for the nicest observations. The large speculum of platina weighs fourteen pounds: it is eight inches in diameter, and its focus is six feet. Though the high price of platina will, in all probability, for ever prevent it from coming into general use for the speculums of telescopes, we thought it proper to notice this discovery, and shall now proceed to the grinding of the speculum.

For accomplishing this object, a very complicated process is recommended in Smith's Optics, and one not much more simple, by Mr Mudge in the 67th volume of the *Philosophical Transactions;* but according to Mr Edwards, whose speculums are confessedly the best, neither of these is necessary. Besides a common grindstone, all the tools that he made use of are a rough grinder, which serves also as a polisher, and a bed of hones. When the speculum was cold, he ground its surface bright on a common grindstone, previously brought to the form of the gage; and then took it to the rough grinder.

The tool is composed of a mixture of lead and tin, or of pewter, and is made of an elliptical form, of such dimensions, that the shortest diameter of the ellipse is equal to the diameter of the mirror or speculum, and the longest diameter is to the shortest in the proportion of ten to nine. This rough grinder may be fixed upon a block of wood, in order to raise it higher from the bench; and as the metal is ground upon it with fine emery, Mr Mudge, with whom, in this particular, Mr Edwards agrees, directs a hole or pit to be made in the middle of it as a lodgement for the emery, and deep grooves to be cut out across its surface with a graver for the same purpose. By means of a handle, fixed on the back of the metal with soft cement, the speculum can be whirled round upon this grinder so rapidly, that a common labourer has been known to give a piece of metal, four inches in diameter, so good a face and figure as to fit it for the hones in the space of two hours. The emery, however fine, will break up the metal very much; but that is remedied by the subsequent processes of honing and polishing.

When the metal is brought to a true figure, it must be taken to a convex tool, formed of some stones from a place called Edgedon in Shropshire, situated between Ludlow and Bishop's Castle. The common blue hones, used by many opticians for this purpose, will scarcely touch the metal of Mr Edwards's speculums; but where they must be employed for want of the others, as little water should be used as possible when the metal is put upon them; because it is found by experience that they cut better when but barely wet, than when drenched with water. The stones, however, from Edgedon are greatly preferable; for they cut the metal more easily, and having a very fine grain, they bring it to a smooth face. These stones are directed by Mr Mudge to be cemented in small pieces upon a thick round piece of marble, or of metal made of tin and lead like the former composition, in such a manner, that the lines between the stones may run straight from one side to the other; so that placing the teeth of a very fine saw in each of these divisions, they may be cleared from one end to the other of the cement which rises between the stones. As soon as the hones are cemented down, this tool must be fixed in the lathe, and turned as exactly true to the gage as possible. It should be of a circular figure, and but very little larger than the metal intended to be figured upon it. If it be made considerably larger, it will grind the metal into a larger sphere and a bad figure; and if it be made exactly of the same size, it will work the metal indeed into a figure truly spherical, but will be apt to shorten its focus, unless the metal and tool be worked alternately upwards. On these accounts, Mr Edwards recommends it to be made about one twentieth part longer in diameter than the speculum, because he has found that it does not then alter its focus; and he earnestly dissuades the use of much water on the hone pavement at the time of using it, otherwise, he says, that the metal in different parts of it will be of different degrees of brightness.

The metal being brought to a very fine face and figure by the bed of stones, is ready to receive a polish, which is given to it by the elliptical rough grinder covered with pitch. With respect to the consistency of this pitch, Mr Mudge and Mr Edwards give very different directions. Whilst the former says that it should be neither too hard nor too soft, the latter affirms that the harder the pitch is, the better figure it will give to the metal. Pitch may be easily made of a sufficient hardness by adding a proper quantity of rosin; and when it is hardened in this way, it is not so brittle as pitch alone, which is hardened by boiling. Mr Edwards advises to make the mixture just so hard as to receive, when cold, an impression from a moderate pressure of the nail of one's finger. When the elliptical tool is to be covered with this mixture, it must be made pretty warm, and in that state have the mixture poured upon it when beginning to cool in the crucible. Our author

Speculum. author recommends this coating to be made everywhere of about the thicknefs of half a crown; and to give it the proper form, it muft, when fomewhat cool, be preffed upon the face of the mirror, which has firft been dipped in cold water, or covered over with very fine writing paper. If it be not found to have taken the exact figure from the firft preffure, the furface of the pitch muft be gently warmed, and the operation repeated as before. All the fuperfluous pitch is now to be taken away from the edge of the polifher with a pen knife, and a hole to be made in the middle, accurately round, with a conical piece of wood. This hole fhould go quite through the tool, and fhould be made of the fame fize, or fomewhat lefs than the hole in the middle of the fpeculum. Mr Edwards fays, that he has always found that fmall mirrors, though without any hole in the middle, polifh much better, and take a more correct figure, for the polifher's having a hole in the middle of it.

The polifher being thus formed, it muft be very gently warmed at the fire, and divided into feveral fquares by the edge of a knife. Thefe, by receiving the fmall portion of metal that works off in polifhing, will caufe the figure of the fpeculum to be more correct than if no fuch fquares had been made. Mr Mudge directs the polifher to be ftrewed over with very fine *putty*; but Mr Edwards prefers COLCOTHAR of vitriol. Putty (fays he) gives to metals a white luftre, or, as workmen call it, a filver hue; but good colcothar of vitriol will polifh with a very fine and high black luftre, fo as to give the metal finifhed with it the complexion of polifhed fteel. To know if the colcothar of vitriol is good, put fome of it into your mouth, and if you find it diffolves away it is good; but if you find it hard, and crunch between your teeth, then it is bad, and not well burned. Good colcothar of vitriol is of a deep red, or of a deep purple colour, and is foft and oily when rubbed between the fingers; bad colcothar of vitriol is of a light red colour, and feels harfh and gritty. The colcothar of vitriol fhould be levigated between two furfaces of polifhed fteel, and wrought with a little water; when it is worked dry, you may add a little more water, to carry it lower down to what degree you pleafe. When the colcothar of vitriol has been wrought dry three or four times, it will acquire a black colour, and will be low enough, or fufficiently fine, to give an exquifite luftre. This levigated colcothar of vitriol muft be put into a fmall phial, and kept with fome water upon it. When it is to be ufed, every part of the pitch-polifher muft be firft brufhed over with a fine camel's hair brufh, which has been dipped in pure water, and rubbed gently over a piece of dry clean foap. The wafhed colcothar of vitriol is then to be put upon the polifher; and Mr Edwards directs a large quantity of it to be put on at once, fo as to faturate the pitch, and form a fine coating. If a fecond or third application of this powder be found neceffary, it muft be ufed very fparingly, or the polifh will be deftroyed which has been already attained. When the metal is nearly polifhed, there will always appear fome black mud upon its furface, as well as upon the tool. Part of this muft be wiped away with fome very foft wafh leather; but if the whole of it be taken away, the polifhing will not be fo well completed.

With refpect to the *parabolic figure* to be given to the mirror, Mr Edwards affures us, that a very little experience in thefe matters will enable any one to give it with certainty, by polifhing the fpeculum in the common manner, only with crofs ftrokes in every direction, upon an elliptical tool of the proper dimenfions. Speculum ‖ Speech.

SPECULUM, a looking glafs or mirror, capable of reflecting the rays of the fun.

SPECULUM, in *Surgery*, an inftrument for dilating a wound, or the like, in order to examine it attentively. See SURGERY.

SPEECH, in general, the art or act of expreffing a perfon's thoughts by means of articulate founds, which we call words. See LANGUAGE, GRAMMAR, READING, and ORATORY, Part IV.

SPEED, JOHN, an Englifh hiftorian, was born at Farington, in Chefhire, in the year 1542. He was by profeffion a taylor, and freeman of the company of merchant taylors in the city of London. In 16 6, he publifhed his Theatre of Great Britain, which was afterwards reprinted in folio, under the title of the *Theatre of the Empire of Great Britain*. His Genealogies of Scripture were firft bound up with the Bible in 1611, when the firft edition of the prefent tranflation was printed. In 1614 appeared his *Hiftory of Great Britain*, which has been tranflated into Latin; and in 1616 he publifhed his *Cloud of Witneffes*, in octavo. He lived in marriage 57 years with his wife, by whom he had twelve fons and fix daughters; and died in 1629. He was interred in the church of St Giles's, Cripplegate, London, where a monument was erected to his memory.

SPEEDWELL. See VERONICA, BOTANY *Index*.

SPELL, a charm confifting of fome words of occult power, generally attended with fome ceremony.—In order to explain it, we will produce a few examples. On St Agnes's night, 21ft of January, take a row of pins, and pull out every one, one after another, faying a Pater-nofter on fticking a pin in your fleeve, and you will dream of him or her you fhall marry.

Another method to fee a future fpoufe in a dream. The party inquiring muft lie in a different county from that in which he commonly refides, and on going to bed muft knit the left garter about the right-legged ftocking, letting the other garter and ftocking alone; and as he rehearfes the following verfes, at every comma knit a knot: *Grofe's Provincial Gloffary.*

This knot I knit,
To know the thing I know not yet;
That I may fee
The man (woman) that fhall my hufband (wife) be;
How he goes, and what he wears,
And what he does all days and years.

Accordingly, in a dream, he will appear with the infignia of his trade or profeffion.

Another, performed by charming the moon, thus: At the firft appearance of the new moon, immediately after the new year's day, (though fome fay any other new moon is as good), go out in the evening, and ftand over the fpars of a gate or ftile, and, looking on the moon, repeat the following lines:

All hail to the moon! all hail to thee!
I prithee, good moon, reveal to me
This night who my hufband (wife) muft be.

 Immediately

Immediately after you must go to bed, when you will dream of the person destined for your future husband or wife.

SPELLING, in *Grammar*, that part of orthography which teaches the true manner of resolving words into their syllables.

All words are either simple or compound, as *use*, *disuse*; *done*, *undone*; and the rules for dividing each must be such as are derived from the analogy of language in general, or from the established custom of speaking; which, for the English language, are reduced to the following rules: 1. A consonant between two vowels must be joined with the latter in spelling, as *na-ture*, *ve-ri-ly*, *ge-ne-rous*; except, however, the letter *x*, which is joined to the first, as in *flax-en*, *ox-en*, &c. and compound words, as in *up-on*, *un-used*, &c. 2. A double consonant must be divided, as in *let-ter*, *man-ner*, &c. 3. Those consonants which can begin a word must not be parted in spelling, as in *de-fraud*, *re-prove*, *di-stinct*; however, this rule is found sometimes to fail; for though *gn* begins a word, as *gnaw*, *gnat*, &c. yet it must be divided in spelling, as in *cog-ni-zance*, *ma-lig-ni-ty*, &c. 4. Those consonants which cannot begin a word must be divided, as *ld* in *seldom*, *lt* in *mul-ti-tude*, *mp* in *temper*, *rd* in *ar-dent*; but in final syllables there are exceptions, as *tl* in *ti-tle*, *dl* in *han-dle*, &c. 5. When two vowels come together, and are both of them distinctly sounded, they must be separated in spelling, as in *co-e-val*, *mu-tu-al*, &c. 6. The grammatical terminations or endings must be separated in spelling, as *ed* in *wing-ed*, *edst* in *de-li-ver-edst*, *ing* in *hear-ing*, *ance* in *de-li-ver-ance*, &c. 7. Compound words must be resolved into their simple or component words, as *up-on*, *in-to*, *ne-ver-the-less*, *not-with-stand-ing*, &c.

SPELMAN, Sir Henry, an eminent English antiquarian, was descended from an ancient family, and born at Congham, near Lynn in Norfolk, about the year 1561. He was knighted by King James I. who had a particular esteem for him on account of his known capacity for business; and he employed him several times in Ireland on public affairs. When he was about 50 years of age, he went to reside in London; where falling into a study to which his own genius had always inclined him, he collected all such books and MSS. as concerned the subject of antiquities, either foreign or domestic. In 1626, he published the first part of his well-known Glossary, which he never carried beyond the letter L; because, as some have suggested, he had said things under "Magna charta," and "Maximum consilium," that could not then have appeared without giving offence. Upon his death all his papers came into the hands of his son Sir John Spelman, a gentleman who had abilities to have completed his father's design, if death had not prevented him. The second part was afterwards published by Sir William Dugdale; but with all the marks of a scanty unfinished performance. The next work he entered upon was an edition of the English Councils, of which he published the first volume about two years before his death, leaving the second volume, as well of this as of his Glossary, to be published by Sir William Dugdale. Sir Henry wrote several other things, all relating to ancient laws and customs, and died in 1641. His Posthumous Works were published in folio, 1698, under the inspection of Mr Gibson, afterwards bishop of London.

SPELTER, in *Metallurgy*, the same with Zinc.

SPENCE, Joseph, an eminent writer, was fellow of New College, Oxford, where he took the degree of A.M. in 1727. About that time he became first known as an author, by an *Essay on Pope's Odyssey, in which some particular beauties and blemishes of that work are considered*; a work of great merit, and which for sound criticism and candid disquisition is almost without a parallel. He was elected professor of poetry by the university in 1728, and held that office ten years, which is as long as the statutes will allow. His History of Stephen Duck was first published in 1731; but it was afterwards much altered, and prefixed to an edition of Duck's poems.

About this time he travelled into Italy as tutor to the earl of Lincoln, afterwards duke of Newcastle.—In 1736 he republished Gorboduc, at Mr Pope's desire, with a preface giving an account of the author, the earl of Dorset. He quitted his fellowship in 1742, upon being presented by the Society of New College to the rectory of Great Harwood in Buckinghamshire.—He never resided in his living; but paid it an annual visit, distributing large sums of money among the poor, and providing for many of their children. The same year he was made professor of modern history at Oxford. In 1747 he published *Polymetis*; or an inquiry concerning the agreement between the works of the Roman poets and the remains of ancient artists, being an attempt to illustrate them mutually from each other. This work was treated by Gray with a contempt which it did not deserve. He raises objections because the author did not illustrate his subject from Greek writers; that is, because he failed to execute what he never undertook. He was installed prebendary of the seventh stall at Durham the 24th May 1754. He published the same year, "An Account of the Life, Character, and Poems, of Mr Blacklock, student of philosophy at Edinburgh;" which was afterwards prefixed to his Poems. The prose pieces which he printed in the Museum he collected and published, together with some others, in a pamphlet called *Moralities*, by Sir Harry Beaumont. Under the same name he published "Crito, or a Dialogue on Beauty," and "A particular Account of the emperor of China's Gardens near Pekin, in a letter from F. Attiret, a French missionary now employed by that emperor to paint the apartments in those gardens, to his friend at Paris." Both these treatises are printed in Dodsley's fugitive pieces, as is also "A Letter from a Swiss Officer to his friend at Rome;" which Mr Spence first published in the Museum. In 1758 he published "A Parallel, in the Manner of Plutarch, between a most celebrated man of Florence and one scarce ever heard of in England." This was also inserted in the fugitive pieces. The same year he made a journey into Scotland, which he described in an affectionate letter to Mr Shenstone, published in Hall's Collection of Letters, 1778. In 1764 he was very well described by Mr James Ridley, in his admirable Tales of the Genii, under the name of *Phesoi Ecneps* (his name read backwards), dervise of the groves. A letter from Mr Spence to that ingenious moralist, under the same signature, is preserved in the 3d volume of "Letters

ters of Eminent Perfons." In 1768 he publifhed "Remarks and Differtations on Virgil, with fome other claffical obfervations, by the late Mr Holdfworth." On the 20th of Auguft the fame year he was unfortunately drowned in a canal in his garden at Bytleet in Surrey. He was found flat upon his face at the edge of the canal, where the water was fo fhallow as not even to cover his head. The accident, it was fuppofed, for he was quite alone, was owing to a fit.

The duke of Newcaftle poffeffes fome manufcript volumes of anecdotes collected by Mr Spence, from which Dr Johnfon was permitted to infert many extracts in his Lives of the Poets.

SPENCER, Dr John, an eminent divine, was born in Kent in 1630, and educated at Cambridge. He was chofen fellow of his college, and took a doctor's degree in 1663. In 1667 he was chofen mafter of Corpus Chrifti College, and preferred to the deanery of Ely in 1677. He died on the 20th of May 1695. His works are, 1. The Righteous Ruler; a fermon on Proverbs xxix. 2. preached June 28. 1660. 2. A Difcourfe concerning Prodigies, wherein the vanity of prefages by them is reprehended, and their true and proper ends afferted and vindicated. To this excellent work was afterwards added, A Difcourfe concerning vulgar prophecies, wherein the vanity of receiving them as the certain indications of any future event is expofed; and fome marks of diftinction between true and pretended prophets are laid down. 3. A Latin Differtation concerning Urim and Thummim. 4. His famous treatife *De legibus Hebræorum ritualibus et earum rationibus*. The intention of this book, as he informs us himfelf, was to vindicate the Deity from the imputation of acting from arbitrary and fantaftical motives. It has been highly and juftly efteemed both for the elegance of ftyle and the uncommon erudition and found fenfe which it difplays. It has, however, (that part of it particularly which endeavours to deduce fome of the Jewifh ceremonies from the practices of their heathen neighbours), alarmed many perfons, as if fuch a doctrine, if it could be proved, would derogate from the Divine wifdom, and undermine revelation. But this is fo far from being the cafe, that Dr Spencer's attempt, whether fuccefsful or not, deferves the gratitude of Chriftians, becaufe it has a tendency to throw light on an important and difficult fubject.

SPENSER, Edmund, the poet, was born in London in the year 1553, and defcended from an ancient family of the Spenfers in Northamptonfhire. All we know concerning his education is, that he was admitted a fizer of Pembroke-hall in Cambridge, and matriculated in 1569. At this time began his intimacy with Mr Gabriel Harvey, a man of genius and a poet. In 1576, having completed his degrees in arts, he left the univerfity, as it is conjectured, for want of fubfiftence, and retired to the north of England. Here he had the misfortune to become enamoured of his Rofalind, who, after flattering his paffion for a time, at length preferred his happier rival. Spenfer continued in the country till the year 1578, when at the perfuafion of his friend Mr Harvey he removed to London, where that gentleman introduced him to Mr Sidney (afterwards Sir Philip Sidney). Concerning his firft introduction to Sir Philip, there is indeed a different ftory, which was firft told by the writer of his life, prefixed to his works in 1679, and tranfcribed by Hughes, Cibber, and feveral others; which, neverthelefs, is certainly not true. The purport of it is, that Spenfer, being unknown to this Mecænas of the age, went to Leicefter-houfe, and fent in the 9th canto of the firft book of the Fairy Queen; that, on reading part of it, Sir Philip ordered his fteward to give the bearer 50l.; on reading a little farther 50l. more; then 200l. bidding him to make hafte and pay the money, left he fhould give the poet his whole eftate. The ftory tells prettily enough; but it is very certain, that the Fairy Queen was begun long after his acquaintance with Sir Philip. By this univerfal patron of genius, however, he was prefented to Queen Elizabeth, who honoured him with the place of poet-laureat. About this time he finifhed his Shepherd's Calendar, which was firft printed in 1579; and in the following year, being recommended by his patron to the earl of Leicefter, he went to Ireland as fecretary to the lord Grey of Wilton, then appointed lord-lieutenant of that kingdom. Lord Grey was recalled in 1582, and with him Spenfer returned to London, where he continued till after the death of Sir Philip Sidney in 1586; a lofs which he bewailed to the end of his life. The following year, our poet, having obtained a royal grant of 3000 acres of forfeited lands in the county of Cork in Ireland, fet out for that kingdom, took poffeffion of his eftate, and fixed his refidence in the caftle of Kilcolman, which had belonged to the earl of Defmond. In this retirement he refumed his great work of the Fairy Queen; and continued in Ireland till, being vifited by his old friend Sir Walter Raleigh in 1589, he came over with him to England, but returned to Ireland the year following, where he fell in love with a country girl, and married her. Soon after his marriage, he paid another vifit to his native country, where we alfo find him in 1596. In the following year he returned once more to Kilcolman; but on the rebellion of Lord Tyrone, who ravaged the whole county of Cork, he was obliged to fly for fafety with his family to England, where, in the year 1599, he died in extreme poverty (A). He was buried in Weftminfter Abbey, according to his requeft, near Chaucer. A monument was erected to his memory by Ann countefs of Dorfet. We know but little of his character as a man; as a poet, confidering the age in which he lived, he deferves our utmoft veneration. He wrote various pieces befides thofe above mentioned. His whole works, with his life by Hughes, were publifhed in fix volumes 12mo, in 1715 and 1750.

SPERGULA, Spurrey, a genus of plants belonging to the clafs of decandria; and in the natural fyftem arranged

(A) This is Camden's account, and it has been generally believed; but Mr Malone, the laft editor of Shakefpeare's works, by examining the patent roll, 33 Eliz. p. 3. has difcovered, that in February 1690-1 Spenfer obtained from Queen Elizabeth an annuity or penfion of 50l. during his life; a fum equivalent to 200l. at prefent.

arranged under the 22d order, *caryophylleæ*. See BOTANY *Index*.

SPERM, the feed whereof an animal is formed. See PHYSIOLOGY.

SPERMACETI, a whitifh, unctuous, flaky fubftance, prepared from oil, but chiefly from the brains of a fpecies of whale called *phyfeter macrocephalus*.

The method of preparing fpermaceti is kept a fecret; but the procefs is faid to be this: The brains being taken out of the animal, are then, as fome fay, melted over a gentle fire, poured into moulds, and when cold melted again; and this procefs is continued till they are purified. Others fay, that after being preffed and drained they are more thoroughly purified by fteeping them in a ley of alkaline falt and quicklime. The brains are then wafhed, and cut into thin flakes or flices with wooken knives. One fifh is faid to afford fome tons of brains. Good fpermaceti is gloffy and femitranfparent, in fine white flakes; foft and unctuous to the touch, yet dry and friable; in tafte, fomewhat like butter, and of a faint fmell like that of tallow. Some adulterate it with wax; but the deceit is difcovered, either by the fmell of the wax or by the dulnefs of the colour. Some alfo fell a preparation of oil taken from the tail of the whale inftead of that from the brain; but this kind turns yellow as foon as expofed to the air. Indeed it is apt in general to grow yellowifh, and to contract a rancid fifhy fmell if not carefully fecured from the air. The more perfectly it has been purified at firft, the lefs fufceptible it is of thefe alterations; and after it has been changed, it may be rendered white and fweet again by fteeping it afrefh in a ley of alkaline falt and quicklime. It melts in a fmall degree of heat, and congeals again as it cools.

Spermaceti is of ufe in medicine. Quincy fays it is a noble remedy in the afthma, &c. though chiefly ufed in bruifes, inward hurts, and after delivery. For internal ufe, it may be diffolved in aqueous liquors into the form of an emulfion, by trituration with almonds, the yolk or white of an egg, and more elegantly by mucilages; or made into a lohoch, by mixing two drams of it with a fuitable quantity of yolk of egg, then adding half an ounce of frefh drawn oil of almonds, and an ounce of balfamic fyrup. Spermaceti is not capable of being diffolved by cauftic alkalies, and of forming foaps, like other oily matters: but it is altogether foluble in oils, and unites by liquefaction with wax and refins; and in thefe forms is applied externally. But it is certain, its greateft property, and that which makes it fo much in vogue in many places, is its foftening the fkin. Whence it comes to be ufed by the ladies in paftes, wafhes, &c.

Spermaceti candles are of modern manufacture: they are made fmooth, with a fine glofs, free from rings and fcars, fuperior to the fineft wax candles in colour and luftre; and, when genuine, leave no fpot or ftain on the fineft filk, cloth, or linen.

A method has been lately propofed by Dr Smith Gibbes of Briftol, to convert animal mufcle into a fubftance much refembling fpermaceti. The procefs is remarkably fimple: Nothing more is neceffary than to take a dead carcafe and expofe it to a ftream of running water: it will in a fhort time be changed to a mafs of fatty matter. To remove the offenfive fmell, a quantity

Phil. Tranf. 1794.

of nitrous acid may then be poured upon it, which uniting with the fetid matter, the fat is feparated in a pure ftate. This acid indeed turns it yellow, but it may be rendered white and pure by the action of the oxygenated muriatic acid. Mr Gibbes brought about the fame change in a much fhorter time. He took three lean pieces of mutton and poured on them the three mineral acids, and he perceived that at the end of three days each was much altered; that in the nitrous acid was much foftened, and on feparating the acid from it, he found it to be exactly the fame with that which he had before got from the water; that in the muriatic acid was not in that time fo much altered; the vitriolic acid had turned the other black.

SPERMACOCE, BUTTON-WOOD, a genus of plants belonging to the clafs of tetrandria; and in the natural fyftem arranged under the 47th order, *ftellatæ*. See BOTANY *Index*.

SPERMATIC, in *Anatomy*, fomething belonging to the fperm or feed.

SPEUSIPPUS, an Athenian philofopher, the nephew and fucceffor of Plato. Contrary to the practice of Plato, Speufippus required from his pupils a ftated gratuity. He placed ftatues of the Graces in the fchool which Plato had built. On account of his infirm ftate of health, he was commonly carried to and from the academy in a vehicle. On his way thither he one day met Diogenes, and faluted him; the furly philofopher refufed to return the falute, and told him, that fuch a feeble wretch ought to be afhamed to live; to which Speufippus replied, that he lived not in his limbs, but in his mind. At length, being wholly incapacitated, by a paralytic ftroke, for the duties of the chair, he refigned it to Xenocrates. He is faid to have been of a violent temper, fond of pleafure, and exceedingly avaricious. Speufippus wrote many philofophical works, which are now loft, but which Ariftotle thought fufficiently valuable to purchafe at the expence of three talents. From the few fragments which remain of his philofophy, it appears that he adhered very ftrictly to the doctrine of his mafter.

SPEY, a river of Scotland, rifing from a lake of the fame name in Badenoch, and, after a ferpentine courfe of 76 miles, paffes by Rothes caftle, and falls into the German fea at Garnoch near Elgin. Mr Pennant tells us, that the Spey is a dangerous neighbour to Caftle Gordon, overflowing frequently in a dreadful manner, as appears by its ravages far beyond its banks. The bed of the river is wide and full of gravel, and the channel very fhifting. In 1746 the duke of Cumberland paffed this river at Belly church, near Caftle Gordon, when the channel was fo deep as to take an officer, from whom Mr Pennant had the account, and who was fix feet four inches high, up to the breaft. The banks are here very high and fteep; fo that had not the rebels been infatuated in fuch a manner as to neglect oppofition, the paffage muft have been attended with confiderable lofs. On this river there is a great falmon-fifhery; about 1700 barrels full are caught in the feafon, and the fhore was formerly rented for about 1200l. per annum: now it is probably doubled.

SPHACELUS, in *Surgery* and *Medicine*, an abfolute and perfect corruption or death of the parts.

SPHÆRANTHUS, a genus of plants belonging to the

the clafs of fyngenefia, and to the order of polygamia fegregata; and in the natural fyftem arranged under the 49th order, *Compofitæ*. See BOTANY *Index*.

SPHAGNUM, BOG-MOSS, a genus of plants belonging to the clafs of cryptogamia and order of mufci. See BOTANY *Index*.

Os SPHENOIDES, the feventh bone of the cranium or fkull. See ANATOMY, N° 11.

SPHERE, is a folid contained under one uniform round furface, every point of which is equally diftant from a certain point in the middle called its *centre*; and is formed by the revolution of a femicircle about its diameter. See GEOMETRY.

Projection of the SPHERE. See PROJECTION.

SPHERE, in *Aftronomy*, that concave orb or expanfe which invefts our globe, and in which the heavenly bodies appear to be fixed, and at an equal diftance from the eye.

The better to determine the places of the heavenly bodies in the fphere, feveral circles are fuppofed to be defcribed on the furface thereof, hence called the *circles of the fphere*: of thefe fome are called *great circles*, as the equinoctial, ecliptic, meridian, &c. and others *fmall circles*, as the tropics, parallels, &c. See GEOGRAPHY; and ASTRONOMY, *paffim*.

Armillary SPHERE. See GEOGRAPHY.

SPHERE of Activity of a Body, is that determinate fpace or extent to which, and no farther, the effluvia continually emitted from that body reach; and where they operate according to their nature.

SPHERES, in *Optics*, the fame with metalline mirrors, for telefcopes or other purpofes. See MIRROR.

SPHEROID, in *Geometry*, a folid approaching to the figure of a fphere. It is generated by the entire revolution of a femi-ellipfis about its axis. When the revolution is made round the largeft axis, the fpheroid is called *prolate*; and when round the fhorteft, *oblate*. This laft is the figure of the earth, and probably of all the planets.

SPHEX, ICHNEUMON WASP, or *Savage*; a genus of infects belonging to the order of *hymenopteræ*. See ENTOMOLOGY *Index*.

SPHINCTER, in *Anatomy*, a term applied to a kind of circular mufcles, or mufcles in form of rings, which ferve to clofe and draw up feveral orifices of the body, and prevent the excretion of the contents.

SPHINX, in fabulous hiftory, a monfter which had the head and breafts of a woman, the body of a dog, the tail of a ferpent, the wings of a bird, the paws of a lion, and a human voice. It fprang from the union of Orthos with the Chimæra, or of Typhon with Echidna. The Sphinx had been fent into the neighbourhood of Thebes by Juno, who wifhed to punifh the family of Cadmus, which fhe perfecuted with immortal hatred, and it laid this part of Bœotia under continual alarms, by propofing enigmas, and devouring the inhabitants if unable to explain them. In the midft of their confternation the Thebans were told by the oracle, that the fphinx would deftroy herfelf as foon as one of the enigmas fhe propofed was explained. In this enigma fhe wifhed to know what animal walked on four legs in the morning, two at noon, and three in the evening. Upon this Creon king of Thebes promifed his crown and his fifter Jocafta in marriage to him who could deliver his country from the monfter by a fuccefsful explanation of the enigma. It was at laft happily explained by Oedipus, who obferved, that man walked on his hands and feet when young, or in the morning of life; at the noon of life he walked erect; and in the evening of his days he fupported his infirmities upon a ftick. (*Vid. Oedipus*). The fphinx no fooner hear this explanation than fhe dafhed her head againft a rock, and immediately expired. Some mythologifts wifh to unriddle the fabulous traditions about the fphinx by the fuppofition that one of the daughters of Cadmus, or Laius, infefted the country of Thebes by her continual depredations, becaufe fhe had been refufed a part of her father's poffeffions. The lion's paw expreffed, as they obferve, her cruelty, the body of the dog her lafcivioufnefs, her enigmas the fnares fhe laid for ftrangers and travellers, and her wings the difpatch fhe ufed in her expeditions.

Lempriere's Bibliotheca Claffica.

Among the Egyptians the fphinx was the fymbol of religion, by reafon of the obfcurity of its myfteries; and on the fame account the Romans placed a fphinx in the pronaos or porch of their temples. Sphinxes were ufed by the Egyptians to fhow the beginning of the water's rifing in the Nile: with this view, as it had the head of a woman and body of a lion, it fignified that the Nile began to fwell in the months of July and Auguft, when the fun paffes through the figns of Leo and Virgo. There are feveral of thefe ftill to be feen; one in particular, near the pyramids, much fpoken of by the ancients; being of a prodigious fize, and cut out of the rock; the head and neck appear only at prefent, the reft of the body being hid in the fand. This, according to Thevenot, is 26 feet high, and 15 feet from the ear to the chin: but Pliny affures us, the head was no lefs than 102 feet in circumference, and 62 feet high from the belly, and that the body was 143 feet long, and was thought to be the fepulchre of King Amafis.

The learned Mr Bryant * obferves, that the fphinx feems to have been originally a vaft rock of different ftrata; which, from a fhapelefs mafs, the Egyptians fafhioned into an object of beauty and veneration. The Egyptians ufed this figure in their building; from them the Greeks derived it, and afterwards improved it into an elegant ornament. It is alfo frequently ufed in modern architecture.

* *Ancient Mythology*, vol. ii. p. 532.

It is proper to obferve, that the fphinx of the Egyptians is faid in the Afiatic Refearches † to have been found in India. Colonel Pearfe was told by Murari Pandit, a man of learning among the Hindoos, that the fphinx, there called *fingh*, is to appear at the end of the world, and as foon as he is born will prey on an elephant: he is therefore figured feizing an elephant in his claws; and the elephant is made fmall, to fhow that the *fingh*, even a moment after his birth, will be very large in proportion to it. But in oppofition to this account given by Murari Pandit, the late Sir William Jones, the learned and illuftrious prefident of the Afiatic Society, was affured by feveral Brahmans, that the figure taken for a fphinx was a reprefentation of a lion feizing a young elephant. This point therefore requires farther inveftigation.

† Vol. ii. p. 334.

SPHINX, *HAWK-Moth*, a genus of infects belonging to the order of *lepidopteræ*. See ENTOMOLOGY *Index*.

SPIGELIA, WORM-GRASS, a genus of plants belonging to the clafs of pentandria; and in the natural fyftem arranged under the 47th order, *Stellatæ*. See BOTANY and MATERIA MEDICA *Index*.

SPICE, any kind of aromatic drug that has hot and pungent qualities: fuch are pepper, nutmeg, ginger, cinnamon, cloves, &c.

SPICE-Iflands, in the Eaft Indies. See BANDA, *MOLUCCA-Iflands*, and CEYLON.

SPIDER. See ARANEA, ENTOMOLOGY *Index*.

SPIDERWORT. See PHALANGIUM, } BOTANY *Index*.
SPIGNEL. See ATHAMANTA, }

SPIKE, or *Oil of SPIKE*, a name given to an effential oil diftilled from lavender, and much ufed by the varnifh-makers and the painters in enamel.

SPIKENARD. See NARDUS, BOTANY *Index*.

SPILANTHUS, a genus of plants belonging to the clafs of fyngenefia. See BOTANY *Index*.

SPINA CERVINA, an old name for rhamnus catharticus. See RHAMNUS, BOTANY *Index*.

SPINA-Ventofa, in *Surgery*, that fpecies of corruption of the bones which takes its rife in the internal parts, and by degrees enlarges the bone, and raifes it into a tumor. See SURGERY.

SPINACIA, SPINAGE, a genus of plants belonging to the clafs of diœcia; and in the natural fyftem arranged under the 12th order, *Holoraceæ*. See BOTANY *Index*; and for an account of the method of cultivating fpinage in the garden, fee GARDENING.

SPINAGE, or SPINACH. See SPINACIA.

SPINÆ, in *Botany*, thorns, rigid prickles: a fpecies of *arma*, growing on various parts of certain plants for their defence; *fpinæ ramorum arcent pecora*. On the branches we find examples in the pyrus, prunus, citrus, hippophaes, gmelina, rhamnus, lycium, &c.; on the leaves, in the aloe, agave, yucca, ilex, hippomane, theophrafta, carlina, &c.; on the calyx, in the carduus cnicus, centaurea, moluccella, galeopfis, &c.; on the fruit, in the trapa, tribulus, murex, fpinacia, agrimonia, datura, &c.

SPINAL MARROW. See ANATOMY *Index*.

SPINALIS, in *Anatomy*, the name of feveral mufcles, &c. of the fpine.

SPINDLE, in *Geometry*, a folid body generated by the revolution of fome curve line about its bafe or double ordinate; in oppofition to a conoid, which is generated by the rotation of the curve about its axis or abfcifs, perpendicular to its ordinate. The fpindle is denominated circular, elliptic, hyperbolic, or parabolic, according to the figure of its generating curve.

SPINDLE-TREE. See EUONYMUS, BOTANY *Index*.

SPINE, SPINA DORSI. See ANATOMY, N° 30.

SPINE. See SPINÆ.

SPINET, or SPINNET, a mufical inftrument ranked in the fecond or third place among harmonious inftruments. It confifts of a cheft or belly made of the moft porous and refinous wood to be found, and a table of fir glued on flips of wood called *fummers*, which bear on the fides. On the table are raifed two little prominences or bridges, wherein are placed fo many pins as there are chords or ftrings to the inftrument. It is played on by two ranges of continued keys, the former range being the order of the diatonic fcale, and that behind the order of the artificial notes or femitones. The keys are fo many flat pieces of wood, which, touched and preffed down at the end, make the other raife a jack which ftrikes and founds the ftrings by means of the end of a crow's quill, wherewith it is armed. The 30 firft ftrings are of brafs, the other more delicate ones of fteel or iron-wire; they are all ftretched over the two bridges already mentioned. The figure of the fpinet is a long fquare or parallelogram; fome call it an *harp couched*, and the harp an *inverted fpinet*. See the article HARP.

This inftrument is generally tuned by the ear, which method of the practical muficians is founded on a fuppofition that the ear is a perfect judge of an octave and a fifth. The general rule is to begin at a certain note, as C, taken towards the middle of the inftrument, and tuning all the octaves up and down, and alfo the fifths, reckoning feven femitones to each fifth, by which means the whole is tuned. Sometimes to the common or fundamental play of the fpinet is added another fimilar one in unifon, and a third in octave to the firft, to make the harmony the fuller; they are either played feparately or together by means of a ftop: thefe are called *double* or *triple fpinets*; fometimes a play of violins is added, by means of a bow, or a few wheels parallel to the keys, which prefs the ftrings and make the found laft as long as the mufician pleafes, and heighten and foften them more or lefs, as they are more or lefs preffed. The harpfichord is a kind of fpinet, only with another difpofition of the keys (fee the article HARPSICHORD). The inftrument takes its name from the fmall quill ends which touch the ftrings, refembling *fpinæ* or thorns.

SPINIFEX, a genus of plants belonging to the clafs of *polygamia*. See BOTANY *Index*.

SPINNING, in *Commerce*, the act or art of reducing filk, flax, hemp, wool, hair, or other matters, into thread. Spinning is either performed on the wheel, or with a diftaff and fpindle, or with other machines proper for the feveral kinds of working. Hemp, flax, nettle-thread, and other like vegetable matters, are to be wetted in fpinning: filks, wools, &c. are fpun dry, and do not need water; yet there is a way of fpinning or reeling filk as it comes off the cafes or balls, where hot and even boiling water is to be ufed (fee SILK). The vaft variety, and the importance of thofe branches of our manufactures, which are produced from cotton, wool, and flax, fpun into yarn, together with the cheapnefs of provifions, and the low price of labour in many foreign countries, which are our rivals in trade, have occafioned many attempts at home to render fpinning more eafy, cheap, and expeditious; for which fee *COTTON-Spinning* and *COTTON MILLS*.

To give an intelligible and accurate defcription of a cotton mill would be abundant employment for a volume. Our limits admit of nothing like this; but as we are certain that many of our readers have viewed a cotton mill with wonder, but not with intelligence, or with leifure to trace the fteps by which the wool from the bag ultimately affumes the form of a very fine thread. Bewildered by fuch a complication of machinery, all in rapid motion, very few, we imagine, are able to recollect with diftinctnefs and intelligence the effential part of the progrefs by which the form of the cotton is fo wonderfully changed. Such readers will not think a page or two mifemployed, if they are thereby able to underftand this particular, to which all the reft of the procefs is fubfervient.

We pafs over the operation of carding, by which all the

the clots and inequalities of the cotton wool are removed, and the whole is reduced to an uniform thin fleece, about 20 inches broad. This is gradually detached from the finiſhing card, and, if allowed to hang down from it, would pile up on the floor as long as the mill continues to work; but it is guided off from the card, very tenderly, in a horizontal direction, by laying its detached end over a roller, which is ſlowly turned round by the machine. Another roller lies above the fleece, preſſing it down by its weight. By this preſſure, a gentle hold is taken of the fleece, and therefore the ſlow motion of the rollers draws it gently from the card at the ſame rate as it is diſengaged by the comb; but between the card and the rollers a ſet of ſmooth pins are placed in two rows, leading from the card to the rollers, and gradually approaching each other as we approach the rollers. By theſe pins the broad fleece is hemmed in on both ſides, and gradually contracted to a thick roll; and in this ſtate paſſes between the rollers, and is compreſſed into a pretty firm flat riband, about two inches broad, which falls off from the rollers, and piles up in deep tinplate cans ſet below to receive it.

It is upon this ſtripe or riband of cotton wool that the operation of ſpinning begins. The general effect of the ſpinning proceſs is to draw out this maſſive roll, and to twiſt it as it is drawn out. But this is not to be done by the fingers, pulling out as many cotton fibres at once as are neceſſary for compoſing a thread of the intended fineneſs, and continuing this manipulation regularly acroſs the whole end of the riband, and thus, as it were, nibbling the whole of it away. The fingers muſt be directed, for this purpoſe, by an attentive eye. But in performing this by machinery, the whole riband muſt be drawn out together, and twiſted as it is drawn. This requires great art, and very delicate management. It cannot be done at once; that is, the cotton roll cannot firſt be ſtretched or drawn out to the length that is ultimately produced from a tenth of an inch of the roll, and then be twiſted. There is not coheſion enough for this purpoſe; we ſhould only break off a bit of the roll, and could make no farther uſe of it. The fibres of cotton are very little implicated among each other in the roll, becauſe the operation of carding has laid them almoſt parallel in the roll; and though compreſſed a little by its contraction from a fleece of 20 inches to a riband of only two, and afterwards compreſſed between the diſcharging rollers of the carding machine, yet they cohere ſo ſlightly, that a few fibres may be drawn out without bringing many others along with them. For theſe reaſons, the whole thickneſs and breadth of two or three inches of the riband is ſtretched to a very minute quantity, and then a very ſlight degree of twiſt is given it, viz. about three turns in the inch; ſo that it ſhall now compoſe an extremely ſoft and ſpungy cylinder, which cannot be called a thread or cord, becauſe it has ſcarcely any firmneſs, and is merely rounder and much ſlenderer than before, being ſtretched to about thrice its former length. It is now called ſlab, or roove.

Although it be ſtill extremely tender, and will not carry a weight of two ounces, it is much more coheſive than before, becauſe the twiſt given to it makes all the longitudinal fibres bind each other together, and compreſs thoſe which lie athwart; therefore it will require more force to pull a fibre from among the reſt, but ſtill not nearly enough to break it. In drawing out a ſingle fibre, others are drawn out along with it; and if we take hold of the whole aſſemblage, in two places, about an inch or two inches aſunder, we ſhall find that we may draw it to near twice its length without any riſk of its ſeparating in any intermediate part, or becoming much ſmaller in one part than another. It ſeems to yield equably over all.

Such is the ſtate of the ſlab or roove of the firſt formation. It is uſually called the *preparation;* and the operation of ſpinning is conſidered as not yet begun. This preparation is the moſt tedious, and requires more attendance and hand labour than any ſubſequent part of the proceſs. For the ſtripes or ribands from which it is made are ſo light and bulky, that a few yards only can be piled up in the cans ſet to receive them. A perſon muſt therefore attend each thread of ſlab, to join freſh ſtripes as they are expended. It is alſo the moſt important in the manufacture: for as every inch of the ſlab meets with preciſely the ſame drawing and the ſame twiſting in the ſubſequent parts of the proceſs, therefore every inequality and fault in the ſlab (indeed in the fleece as it quits the finiſhing card) will continue through the whole manufacture. The ſpinning of cotton yarn now divides into two branches. The firſt, performed by what are called *jennies*, perfectly reſembles the ancient ſpinning with the diſtaff and ſpindle; the other, called *ſpinning of twiſt*, is an imitation of the ſpinning with the fly-wheel. They differ in the ſame manner as the ſpinning with the old wool or cotton wheel differs from the ſpinning with the flax-wheel. Mr Arkwright's chief invention, the ſubſtitution of machinery for the immediate work of the human finger, is ſeen only in the manufacture of twiſt. We ſhall therefore confine our attention to this.

The reſt of the proceſs is little more than a repetition of that gone through in making the firſt ſlab or roove. It is formed on bobins. Theſe are ſet on the back part of the drawing frame; and the end of the ſlab is brought forwards toward the attending workman. As it comes forward, it is ſtretched or drawn to about four-thirds of its former length, or lengthened one-third; and is then twiſted about twice as much as before, and in this ſtate wound up on another bobin. In ſome mills two rooves, after having been properly drawn, are brought together through one hole, and twiſted into one; but we believe that, in the greater number of mills, this is deferred to the ſecond drawing. It is only after the firſt drawing that the produce of the operation gets the name of *ſlab;* before this it is called *preparation*, or *roove*, or by ſome other name. The ſlab is is ſtill a very feeble, ſoft, and delicate yarn, and will not carry much more weight than it did before in the form of roove. The perfection of the ultimate thread or yarn depends on this extreme ſoftneſs; for it is this only which makes it ſuſceptible of an equable ſtretching; all the fibres yielding and ſeparating alike.

The next operation is the *ſecond drawing*, which no way differs from the firſt, except in the different proportionings of the lengthening, and the proportion between the lengthening and the ſubſequent twiſt. On theſe points we cannot give any very diſtinct information. It is different in different mills, and with different ſpecies of cotton wool, as may be eaſily imagined. The immediate mechaniſm or manipulation muſt be ſkilfully accommodated to the nature of that friction which

which the fibres of cotton exert on each other, enabling one of them to pull others along with it. This is greatly aided by the contorted curled form of a cotton fibre, and a confiderable degree of elafticity which it poffeffes. In this refpect it greatly refembles woollen fibres, and differs exceedingly from thofe of flax: and it is for this reafon that it is fcarcely poffible to fpin flax in this way: its fibres become lank, and take any fhape by the flighteft compreffion, efpecially when damp in the flighteft degree. But befides this, the furface of a cotton fibre has a harfhnefs or roughnefs, which greatly augments their mutual friction. This is probably the reafon why it is fo unfit for tents and other dreffings for wounds, and is refufed by the furgeon even in the meaneft hofpitals. But this harfhnefs and its elafticity fit it admirably for the manufacture of yarn. Even the fhortnefs of the fibre is favourable; and the manufacture would hardly be poffible if the fibre were thrice as long as it generally is. If it be juft fo long that in the finifhed thread a fibre will rather break than come out from among the reft, it is plain that no additional length can make the yarn any ftronger with the fame degree of compreffion by twining. A longer fibre will indeed give the fame firmnefs of adherence with a fmaller compreffion. This would be an advantage in any other yarn; but in cotton yarn the compreffion is already as flight as can be allowed; were it lefs, it would become woolly and rough by the fmalleft ufage, and is already too much difpofed to teazle out. It can hardly be ufed as fewing thread. Now fuppofe the fibres much longer; fome of them may chance to be ftretched along the flab through their whole length. If the flab is pulled in oppofite directions, by pinching it at each end of fuch fibres, it is plain that it will not ftretch till this fibre be broken or drawn out; and that while it is in its extended ftate, it is acting on the other fibres in a very unequal manner, according to their pofitions, and renders the whole apt to feparate more irregularly. This is one great obftacle to the fpinning of flax by fimilar machinery; and it has hitherto prevented (we believe) the working up of any thing but the *fhorts* or tow, which is feparated from the long fine flax in the operation of hatcheling.

A third, and fometimes even a fourth, drawing is given to the flab formed on the bobins of this fecond operation. The flab produced is now a flender, but ftill extremely foft cord, fufceptible of confiderable extenfion, without rifk of feparation, and without the fmalleft chance of breaking a fingle fibre in the attempt. In one or more of the preparatory drawings now defcribed, two, and fometimes three flabs, of a former drawing, are united before the twift is given them. The practice is different in different mills. It is plain, that unlefs great care be taken to preferve the flab extremely foft and compreffible during the whole procefs, the fubfequent drawing becomes more precarious, and we run a rifk of at laft making a bad loofe thread inftead of a uniform and fimple yarn. Such a thread will have very little lateral connection, and will not bear much handling without feparating into ftrands. The perfection of the yarn depends on having the laft flab as free of all appearance of ftrands as poffible.

The laft operation is the fpinning this flab. This hardly differs from the foregoing drawings in any thing but the twift that is given it after the laft ftretching in its length. This is much greater than any of the preceding, being intended to give the yarn hardnefs and firmnefs, fo that it will now break rather than ftretch any more.

The reader, moderately acquainted with mechanics, cannot but perceive that each of the operations now defcribed, by which the roove is changed into the foft flab, and each of thefe into one flenderer and fomewhat firmer, by alternately teazling out and twining the foft cord, is a fubftitute for a fingle pull of the finger and thumb of the fpinfter, which fhe accommodates precifely to the peculiar condition of the lock of wool which fhe touches at the moment. She can follow this through all its irregularities; and perhaps no two fucceeding plucks are alike. But when we cannot give this momentary attention to every minute portion, we muft be careful to introduce the roove in a ftate of perfect uniformity; and then every inch being treated in the fame manner, the final refult will be equable—the yarn will be uniform.

We are now to defcribe the mechanifm by which all this is effected. But we do not mean to defcribe a cotton mill; we only mean to defcribe what comes into immediate contact with the thread; and in fo doing, to confine ourfelves to what is neceffary for making the reader perceive its ability to perform the required tafk. We fee many cafes where individuals can apply this knowledge to ufeful purpofes. More than this would, we think, be improper, in a national point of view.

Let ABC reprefent the fection of a roller, whofe pivot D does not turn in a pivot hole, but in the bottom of a long narrow notch DE, cut in an iron ftandard. *abc* is the fection of another iron roller, whofe pivot *d* is in the fame notches at each end, while the roller itfelf lies or refts on the roller ABC below it. The furfaces of thefe rollers are fluted lengthwife like a column; only the flutings are very fmall and fharp, like deep ftrokes of engraving very clofe together. It is plain, that if the roller ABC be made to turn flowly round its axis by machinery, in the direction ABC (as expreffed by the dart), the roughnefs of the flutings will take hold of the fimilar roughnefs of the upper roller *abc*, and carry it round alfo in the direction of the dart, while its pivots are engaged in the notches DE, which they cannot quit. If therefore we introduce the end F of the cotton ftring or riband, formed by the carding machine, it will be pulled in by this motion, and will be delivered out on the other fide at H, confiderably compreffed by the weight of the upper roller, which is of iron, and is alfo preffed down by a lever which refts on its pivots, or other proper places, and is loaded with a weight. There is nothing to hinder this motion of the riband thus compreffed between the rollers, and it will therefore be drawn through from the cans. The compreffed part at H would hang down, and be piled up on the floor as it is drawn through; but it is not permitted to hang down in this manner, but is brought to another pair of fharp fluted iron rollers K and L. Suppofing this pair of rollers to be of the fame diameter, and to turn round in the fame time, and in the fame direction, with the rollers ABC, *abc*; it is plain that K and L drag in the compreffed riband at I, and would deliver it on the other fide at M, ftill more compreffed. But the roller K is made (by the wheelwork) to turn round more fwiftly than

Plate CCCCXCIX

Spinning.

than ABC. The difference of velocity at the ſurface of the rollers is, however, very ſmall, ſeldom exceeding one part in 12 or 15. But the conſequence of this difference is, that the ſkein of cotton HI will be lengthened in the ſame proportion; for the upper rollers preſſing on the under ones with a conſiderable force, their ſharp flutings take good hold of the cotton between them; and ſince K and L take up the cotton faſter than ABC and *abc* deliver it out, it muſt either be forcibly pulled through between the firſt rollers, or it muſt be ſtretched a little by the fibres ſlipping among each other, or it muſt break. When the extenſion is ſo very moderate as we have juſt now ſaid, the only effect of it is merely to begin to draw the fibres (which at preſent are lying in every poſſible direction) into a more favourable poſition for the ſubſequent extenſions.

The fibres being thus drawn together into a more favourable poſition, the cotton is introduced between a third pair of rollers O, P, conſtructed in the ſame way, but ſo moved by the wheelwork that the ſurface of O moves nearly or fully twice as faſt as the ſurface of K. The roller P being alſo well loaded, they take a firm hold of the cotton, and the part between K and O is nearly or fully doubled in its length, and now requires a little twining to make it roundiſh, and to conſolidate it a little.

It is therefore led ſloping downwards into a hole or eye in the upper pivot of the firſt fly, called a *jack*. This turns round an upright axis or ſpindle; the lower end of which has a pulley on it to give it motion by means of a band or belt, which paſſes round a drum that is turned by the machinery. This jack is of a very ingenious and complicated conſtruction. It is a ſubſtitute for the fly of the common ſpinning wheel. If made preciſely in the form of that fly, the thread, being ſo very bulky and ſpongy, and unable to bear cloſe packing on the bobin, would ſwag out by the whirling of the fly, and would never coil up. The bobin therefore is made to lie horizontally; and this occaſions the complication, by the difficulty of giving it a motion round a horizontal axis, in order to coil up the twiſted roove. Mr Arkwright has accompliſhed this in a very ingenious manner; the eſſential circumſtances of which we ſhall here briefly deſcribe. A is a roller of hard wood, having its ſurface cut into ſharp flutes longitudinally. On the axis, which projects through the ſide of the general frame, there is a pulley P, connected by a band with another pulley Q, turning with the horizontal axis QR. This axis is made to turn by a contrivance which is different in every different cotton mill. The ſimpleſt of all is to place above the pulley C (which is turned by the great band of the machinery, and thus gives motion to the jack), a thin circular diſc D, looſe upon the axis, ſo as to turn round on it without obſtruction. If this diſc exceed the pulley in breadth about $\frac{1}{10}$th of an inch, the broad belt which turns the pulley will alſo turn it; but as its diameter is greater than that of the pulley, it will turn ſomewhat ſlower, and will therefore have a relative motion with reſpect to the axis QR. This can be employed, in order to give that axis a very ſlow motion, ſuch as one turn of it for 20 or 30 of the jack. This we leave to the ingenuity of the reader. The bobin B, on which the roove is to be coiled up, lies on this roller, its pivots paſſing through upright ſlits in the ſides of the general frame. It lies on A, and is moved round by it, in the ſame manner as the uppermoſt of a pair of drawing rollers lies on the under one, and receives motion from it. It is evident that the fluted ſurface of A, by turning ſlowly round, and carrying the weight of the bobin, compreſſes a little the cotton that is between them; and its flutings, being ſharp, take a ſlight hold of it, and cauſe it to turn round alſo, and thus coil up the roove, pulling it in through the hole E in the upper pivot (which reſembles the fore pivot or eye of a ſpinning wheel fly) in ſo gentle a manner as to yield whenever the motion of the bobin is too great for the ſpeed with which the cotton ſkein is diſcharged by the rollers O and P.—N. B. The axis QR below, alſo gives motion to a guide within the jack, which leads the roove gradually from one end of the bobin to the other, and back again, ſo as to coil it with regularity till the bobin is full. The whole of this internal mechaniſm of the jack is commonly ſhut up in a tin cylinder. This is particularly neceſſary when the whirling motion muſt be rapid, as in the ſecond and third drawings. If open, the jacks would meet with much reſiſtance from the air, which would load the mill with a great deal of uſeleſs work.

The reader is deſired now to return to the beginning of the proceſs, and to conſider it attentively in its different ſtages. We apprehend that the deſcription is ſufficiently perſpicuous to make him perceive the efficacy of the mechaniſm to execute all that is wanted, and prepare a ſlab that is uniform, ſoft, and ſtill very extenſible; in ſhort, fit for undergoing the laſt treatment, by which it is made a fine and firm yarn.

As this part of the proceſs differs from each of the former, merely by the degree of twiſt that is given to the yarn, and as this is given by means of a fly, not materially different from that of the ſpinning wheel for flax, we do not think it at all neceſſary to ſay any thing more about it.

The intelligent reader is ſurely ſenſible that the yarn produced in this way muſt be exceedingly uniform. The uniformity really produced even exceeds all expectation; for even although there be ſome ſmall inequalities in the carded fleece, yet if theſe are not matted clots, which the card could not equaliſe, and only conſiſt of a little more thickneſs of cotton in ſome places than in others, when ſuch a piece of the ſtripe comes to the firſt roller, it will be rather more ſtretched by the ſecond, and again by the bobin, after the firſt very ſlight twining. That this may be done with greater certainty, the weights of the firſt rooving rollers are made very ſmall, ſo that the middle part of the ſkein can be drawn through, while the outer parts remain faſt held.

It is ſaid that a pound of the fineſt Bourbon cotton has been ſpun into a yarn extending a few yards beyond 119 miles!

Theſe contrivances have in ſome parts of Scotland been applied to the ſpinning of flax.

Tranſactions of the Society for the Encouragement of Arts.

SPINNING Wheel. A very conſiderable improvement has been made by Mr Antis of Fulneck near Leeds of the common ſpinning wheel. It is well known, that hitherto much time has been loſt by ſtopping the wheel in order to ſhift the thread from one ſtaple on the flyer to another; but in Mr Antis's wheel the bobbin is made to move backwards and forwards, ſo as to prevent the neceſſity of this perpetual interruption, as well as to obviate

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viate the danger of breaking the thread and loſing the end. This is effected by the axis of the great wheel being extended through the pillar next the ſpinner, and formed into a pinion of one leaf A, which takes into a wheel B, ſeven inches diameter, having on its periphery 97 teeth; ſo that 97 revolutions of the great wheel cauſe one of the leſſer wheel. On this leſſer wheel is fixed a ring of wire *c c c;* which, being ſupported on ſix legs, ſtands obliquely to the wheel itſelf, touching it at one part, and projecting nearly three quarters of an inch at the oppoſite one: near the ſide of this wheel is an upright lever C, about 15 inches long, moving on a centre, three inches from its lower extremity, and connected at the top to a ſliding bar D; from which riſes an upright piece of braſs E, which working in the notch of a pulley drives the bobin F backward and forward, according as the oblique wire forces a pin G in or out, as the wheel moves round. To regulate and aſſiſt the alternate motion, a weight H hangs by a line to the ſliding bar, and paſſing over a pulley I riſes and falls as the bobin advances or recedes, and tends conſtantly to keep the pin in contact with the wire. It is evident, from this deſcription, that one ſtaple only is wanted to the flyer; which, being placed near the extremity K, the thread paſſing through it is by the motion of the bobin laid regularly thereon. For this invention the Society inſtituted at London for the Encouragement of Arts, &c. gave the author a premium of twenty guineas.

SPINOSUS CAULIS, in *Botany*, a ſtem covered with ſtrong woody prickles, whoſe roots are not ſuperficial, but proceeding from the body of the ſtem. When applied to a leaf, *ſpinoſum folium*, it indicates the margin running out into rigid points or prickles, *quod margine exit in acumina duriora, rigida, pungentia.*

SPINOUS, in botany. See SPINOSUS.

SPINOUS Fiſhes, ſuch as have ſome of the rays of the back fins running out into thorns or prickles, as the perch, &c.

SPINOZA, BENEDICT, was born at Amſterdam the 24th November 1632. His father was a Jew of Portugal, by profeſſion a merchant. After being taught Latin by a phyſician, he applied himſelf for many years to the ſtudy of theology, and afterwards devoted himſelf entirely to philoſophy. He began very early to be diſſatisfied with the Jewiſh religion; and as his temper was open, he did not conceal his doubts from the ſynagogue. The Jews, it is ſaid, offered to tolerate his infidelity, and even promiſed him a penſion of a thouſand dollars per annum, if he would remain in their ſociety, and continue outwardly to practiſe their ceremonies. But if this offer was really made, he rejected it, perhaps from his averſion to hypocriſy, or rather becauſe he could not endure the reſtraint which it would have impoſed. He alſo refuſed being conſtituted heir to an independent fortune, to the prejudice of the natural claimants; and he learned the art of poliſhing glaſs for ſpectacles, that he might ſubſiſt independently of every one.

He would probably have continued in the ſynagogue for ſome time longer, had it not been for an accident. As he was returning home one evening from the theatre he was ſtabbed by a Jew: the wound was ſlight; but the attempt naturally led Spinoza to conclude that the Jews had formed the deſign of aſſaſſinating him. After leaving the ſynagogue, he became a Chriſtian, and frequented the churches of the Lutherans and Calviniſts. He now devoted himſelf more than ever to his favourite philoſophical ſpeculations; and finding himſelf frequently interrupted by the viſits of his friends, he left Amſterdam, and ſettled at the Hague, where he often continued for three months together without ever ſtirring from his lodging. During his reſidence in that city, his hoſteſs, who was a Lutheran, aſked him one day if ſhe could be ſaved while ſhe continued in her religion? "Yes (replied Spinoza), provided you join to your religion a peaceable and virtuous life." From this anſwer it has been concluded that he was a Chriſtian in appearance only, while in reality he regarded all religions as indifferent. But this concluſion would be too ſevere, even if the woman had been a Mahometan. His *Tractatus Theologico-politicus*, which was publiſhed about that time, is a better proof of his inſincerity than a thouſand ſuch concluſions; for this book contains all thoſe doctrines in embryo which were afterwards unfolded in his *Opera Poſthuma*, and which are generally conſidered as a ſyſtem of atheiſm.

His fame, which had now ſpread far and wide, obliged him ſometimes to interrupt his philoſophical reveries. Learned men viſited him from all quarters. While the prince of Conde commanded the French army in Utrecht, he intreated Spinoza to viſit him; and though he was abſent when the philoſopher arrived, he returned immediately, and ſpent a conſiderable time with him in converſation. The elector Palatine offered to make Spinoza profeſſor of philoſophy at Heidelberg; which, however, he declined.

He died of a conſumption at the Hague on the 21ſt February 1677, at the age of 45. His life was a perpetual contradiction to his opinions. He was temperate, liberal, and remarkably diſintereſted; he was ſociable, affable, and friendly. His converſation was agreeable and inſtructive, and never deviated from the ſtricteſt propriety.

The only edition of the works of Spinoza that we have ſeen is in two volumes ſmall 4to; the former of which was printed at Hamburg in the year 1670, and the latter we know not where, in 1677, a few months after his death. In the *Tractatus Theologico-politicus*, already mentioned, he treats of *prophecy* and *prophets;* and of the *call of the Hebrews*, whom he affirms to have been diſtinguiſhed from other nations only by the admirable form of their government, and the fitneſs of their laws for long preſerving their political ſtate. He is likewiſe of opinion, or at leaſt pretends to be ſo, that God may, in what we call a *ſupernatural way*, have given political inſtitutes to other nations as well as to the Hebrews, who were, he ſays, at no time a peculiar people to the Supreme Lord of heaven and earth; for according to him, all hiſtory, ſacred and profane, teſtifies that every nation was bleſſed with the light of prophecy. That light indeed, if his notions of it be juſt, was of very little value. He labours to prove, that the prophets were diſtinguiſhed from other men only by their piety and virtue; that their revelations depended wholly on their imaginations and the diſpoſitions of their minds; that they were often groſsly ignorant and highly prejudiced; that the ſpeculative opinions of one prophet are ſeldom in uniſon with thoſe of another; and that their writings are valuable to us only for the excellent rules which he acknowledges they contain reſpecting the prac-

tice

Spinoza. tice of piety and virtue. He then proceeds to treat of the divine law and of miracles; and endeavours to prove that no miracle, in the proper ſenſe of the word, can have been at any time performed; becauſe every thing happens by a neceſſity of nature, the reſult of the divine decrees, which are from all eternity neceſſary themſelves. He acknowledges, that in the Scriptures, which he profeſſes to admit as true hiſtory, miracles are often mentioned; but he ſays that they were only ſingular events which the ſacred hiſtorians *imagined* to be miraculous: and he then gives ſome very extraordinary rules for interpreting the books of the Old and New Teſtaments where they treat of miracles, or appear to foretel future events. See our articles MIRACLE and PROPHECY.

Having thus diveſted the Scriptures of every thing characteriſtic of a revelation from heaven, he next calls in queſtion their authenticity. He affirms, in contradiction to the cleareſt internal evidence, that the Pentateuch and all the other hiſtorical books muſt have been written by one man; and that man, he thinks, could not have flouriſhed at a period earlier than that of Ezra. The grounds of this opinion are unworthy of the talents of Spinoza; for that he had talents is incontrovertible. His principal objection to the authenticity of the Pentateuch is, that Moſes is made to ſpeak of himſelf in the third perſon, and to talk of the Canaanites being then in the land; and becauſe he finds in his writings, as well as in the books of Joſhua, Judges, Ruth, Samuel, &c. places deſigned by names which he ſuppoſes they had not in the early ages of which theſe books contain the hiſtory, he concludes that theſe writings muſt be one compilation from ancient records made at a very late period; more eſpecially as the author often ſpeaks of things of great antiquity remaining to this day. The books of Eſther, Ezra, Nehemiah, and Chronicles, muſt have been compiled, he thinks, under the Maccabees; and he ſeems to conſider as of equal value with them the ſtory of Tobit, and the other two apocryphal treatiſes intitled the Wiſdom of Solomon and Eccleſiaſticus.

Theſe ſenſeleſs cavils, worthy only of one of thoſe modern freethinkers whoſe learning, in the opinion of Biſhop Warburton, is not ſufficient to carry them even to the confines of rational doubt, we have ſufficiently obviated in another place (ſee SCRIPTURE, N° 8—31.) Spinoza urges them againſt the other books of the Old Teſtament. The prophecies of Iſaiah, Jeremiah, Ezekiel, Daniel, Hoſea, and Jonah, are, as we have them, only fragments, he ſays, of the writings of thoſe men compiled by the Phariſees under the ſecond temple from ancient and voluminous records.

In the midſt of this dogmatical ſcepticiſm, if we may uſe ſuch a phraſe, he bears ſuch a teſtimony to the laſt chapters of the book of Daniel, as we ſhould not have looked for in the writings either of a Jew or of a Deiſt. After detailing the various hypotheſes which in his time were held reſpecting the author and the intention of the book of *Job*; in which, he ſays, MOMUS is called SATAN, he proceeds in theſe words: "Tranſeo ad Danielis librum; hic ſine dubio ex cap. 8. ipſius Danielis ſcripta continet. Undenam autem priora ſeptem capita deſcripta fuerint, neſcio *;" thus admitting the famous prophecy of the ſeventy weeks. The canon of the Old Teſtament, he ſays, was finally ſettled by rabbins of the Phariſaical ſect, who wiſhed to exclude from it the books of *Proverbs*, *Eccleſiaſtes*, and *Ezekiel*, as they had actually excluded others of equal value; but the three books in queſtion were inſerted by the influence of two of the rabbis of greater wiſdom and integrity than the reſt.

* *Tractatus*, cap. x. p. 130.

That ſo paradoxical a writer, who had been originally a Jew, and was now almoſt a Deiſt, ſhould have treated the New Teſtament with as little ceremony as the Old, will not ſurpriſe the intelligent reader. He begins his remarks, however, with affirming, that no man can peruſe the Chriſtian Scriptures, and not acknowledge the apoſtles to have been prophets; but he thinks that their mode of propheſying was altogether different from that which prevailed under the Moſaic diſpenſation; and that the gift, whatever it was, forſook them the inſtant that they left off *preaching*, as their *writings* have to him every appearance of human compoſitions. This diſtinction between Chriſtian and Jewiſh prophecy is the more wonderful, that he founds it principally on the diſſimilarity of *ſtyle* viſible in the writings of the Old and New Teſtaments; though, in his ſecond chapter, which treats of the works of the Jewiſh prophets, he ſays expreſsly, "Stylus deinde prophetiæ pro eloquentia cujuſque prophetæ variabat, prophetiæ enim Ezekielis et Amoſis non ſunt, ut illæ Eſaiæ, Nachumi, eleganti, ſed rudiore ſtylo ſcriptæ." That the Hebrew ſcholar may be convinced of the truth of this remark, he recommends to him to ſtudy diligently the writings of theſe prophets, and to conſider the occaſions on which their prophecies were uttered: "Quæ ſi omnia rectè perpendentur (ſays he) facilè oſtendant, Deum nullum habere ſtylum peculiarem dicendi, ſed tantum pro eruditione, et capacitate prophetæ eatenus eſſe elegantem, compendioſum, ſeverum, rudem, prolixum, et obſcurum." Another objection brought by Spinoza againſt the prophecies of the New Teſtament ariſes from the authors of them having been at all times maſters of themſelves. This, ſays he, was peculiarly the caſe of St Paul, who often confirms his doctrine by *reaſoning*, which the Jewiſh prophets never condeſcended to do, as it would have ſubmitted their dogmas to the examination of *private judgment*. Yet, with ſingular inconſiſtency, he affirms, that the Jewiſh prophets could not know that the impreſſions made on their imaginations proceeded from God, but by a ſign given them, which by their own *reaſon* or *judgment* they knew would never be vouchſafed to an impious or a wicked man.

After theſe very free remarks on the Scriptures of the Old and New Teſtaments, he naturally enough expreſſes a ſuſpicion, that by thoſe who conſider the Bible as the epiſtle of God ſent from heaven to men, he will be thought to have ſinned againſt the Holy Ghoſt by vilifying his dictates. This leads him to inquire in what ſenſe the Scriptures are the word of God; and he gravely determines them to be ſo only as they *actually* contribute to make men more virtuous and holy. It is not enough that they are *calculated* to improve virtue and holineſs: for ſhould the words of the languages in which they are written acquire in proceſs of time a ſignification different from what they had originally; ſhould mankind loſe all knowledge of theſe languages; or even ſhould they agree to neglect the books, whether from ignorance or from wilfulneſs—thoſe books would ceaſe

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to be the word of God, and become nothing better than waste paper and ink; just as the two tables, which Moses broke on observing the idolatry of his countrymen, were not the covenant between Jehovah and the Israelites, but merely two pieces of stone! The Scriptures, however, are the word of God, because they teach the true religion of which God is the author; and they have taught it in such a manner, he says, that it can never be lost or corrupted whatever become of the books of the Old and New Testaments, or of the languages in which they are written. The whole of religion, as the Scriptures themselves testify, consists in the love of God above all things, and of our neighbours as ourselves: whence it follows, that we must believe that God exists, and watcheth over all things by his providence; that he is omnipotent, and has decreed the pious to be ultimately happy, and the impious miserable; and that our final salvation depends solely on His grace or favour. These truths, with their necessary consequences, are the word of God: they are clearly taught in the Scriptures, and can never be corrupted; but every thing else in these volumes is vain, he says, and of no greater importance to us than facts related in any other ancient and authentic history.

Such are the opinions which were entertained of revelation by a man, whom a critic, writing in a Christian country, and professing to be a zealous Christian himself, has lately pronounced to have been a *chosen vessel*. For what purpose he was *chosen* it is not easy to conceive. His religion, as it appears in the *Tractatus*, is the worst kind of Deism; and his politics are such as our monthly critics are not wont to teach, and such as we trust shall never be seriously taught by any British subject. By the law of nature, he says, every man before the formation of civil government has an unquestionable right to whatever appears eligible either to his reason or to his appetites; and may get possession of it by *intreaty*, by *violence*, by *fraud*, or by *any other means* attended with less trouble to himself (*sive vi, sive dolo, sive precibus, sive quocunque demum modo facilius poterit*); and may treat as an enemy every person who shall attempt to obstruct his purpose. But when men agree to devolve this right upon others, and to constitute a political state, which both reason and appetite must persuade them to do, then are they in duty bound to obey every mandate of the government, however absurd it may be (*omnia mandata tametsi absurdissima*), as long as that government can enforce its edicts, and no longer; for, according to him, right and power are so inseparably united, that when a government loses its power, it has no longer the smallest claim to obedience. This doctrine, he says, is most *obviously* just when taught of democratical governments; but it is in fact equally true of monarchies and aristocracies: "Nam quisquis summam habet potestatem, sive unus sit, sive pauci, sive denique omnes, certum est ei summum jus *quicquid velit imperandi*, competere: et præterea quisquis potestatem se defendendi, sive sponte, sive *vi coactus*, in alium transtulit, eum suo jure naturali planè cessisse, et consequenter eidem ad omnia absolutè parere decrevisse quod omnia præstare tenetur, quamdiu rex, sive nobiles, sive populus summam, quam acceperunt, potestatem, quæ juris transferendi fundamentum fuit, conservant; nec his plura addere opus est *." We heartily agree with him, that to this precious conclusion it is needless to add a single word.

* *Tractatus*, cap. xvi. p. 18.

Taking our leave therefore of his *Tractatus Theologico-politicus*, we shall now give our readers a short account of his *Opera Posthuma*. These consist of, 1. ETHICA, *more geometrico demonstrata*; 2. POLITICA; 3. DE EMENDATIONE INTELLECTUS; 4. EPISTOLÆ, *et ad eas* RESPONSIONES; 5. COMPENDIUM GRAMMATICES LINGUÆ HEBRÆÆ.

The ETHICA are divided into five parts, which treat in order, *de* DEO; *de natura et origine* MENTIS; *de origine et natura* AFFECTUUM; *de* SERVITUTE *humana, seu de* AFFECTUUM VIRIBUS; *de* POTENTIA INTELLECTUS, *seu de* LIBERTATE *humana*. As the author professes to tread in the footsteps of the geometers, and to deduce all his conclusions by rigid demonstration from a few self-evident truths, he introduces his work, after the manner of Euclid, with a collection of *definitions* and *axioms*. These are couched in terms generally ambiguous; and therefore the reader will do well to consider attentively in what sense, if in any, they can be admitted; for it will not be found easy to grant his premises, and at the same time refuse his conclusions. His definition of substance, for instance, is so expressed as to admit of two senses; in one of which it is just, whilst in the other it is the parent of the most impious absurdity. We shall give it in his own words: "Per substantiam intelligo id, quod in se est, et per se concipitur: hoc est id, cujus conceptus non indiget conceptu alterius rei, à quo formari debeat." If by this be meant, that a substance is that which we can conceive by itself without *attending* to any thing else, or *thinking* of its formation, the definition, we believe, will be admitted by every reflecting mind as sufficiently distinguishing the thing defined from an attribute, which, he says, is that which we perceive *of* a substance, and which we certainly cannot conceive as existing by itself. Thus the writer of this article can shut his eyes and contemplate in idea the small 4to volume now before him, without attending to any thing else, or thinking of its paradoxical author, or even of the Great Being who created the matter both of him and of it; but he cannot for an instant contemplate the yellow colour of its vellum boards without thinking of triple extension, or, in other words, of body. The book therefore is a *substance*, because conceivable by itself; the colour is an *attribute* or *quality*, because it cannot be conceived by itself, but necessarily leads to the conception of something else. But if Spinoza's meaning be, that nothing is a substance but what is conceived as existing from eternity, independent of every thing as a cause, his definition cannot be admitted; for every man conceives that which in himself thinks, and wills, and is conscious, as a substance; at the same time that he has the best evidence possible that he existed not as a conscious, thinking, and active being, from eternity.

His fourth axiom is thus expressed: "Effectus cognitio à cognitione causæ dependet, et eandem involvit;" and his fifth, "Quæ nihil commune cum se invicem habent, etiam per se invicem intelligi non possunt, sive conceptus unius alterius conceptum non involvit." The former of these propositions, so far from being self-evident, is not even true; and the latter is capable of two senses very different from each other. That every ef-

Spinoza.

fect proceeds from *a cauſe*, is indeed an axiom; but ſurely we may know the effect accurately, though we be ignorant of the *particular* cauſe from which it proceeds (ſee PHILOSOPHY, N° 36; and PHYSICS, N° 91, &c.); nor does the knowledge of the one by any means involve the knowledge of the other. If different things have nothing in common, it is indeed true that the knowledge of one of them will not give us an *adequate conception* of the other; but it will in many caſes compel us to believe, that the other *exiſts* or has exiſted. A parcel of gunpowder lying at reſt has nothing in common with the velocity of a cannon-ball; yet when we know that a ball has been driven with velocity from a cannon, we infer with certainty that there has been a parcel of powder at reſt in the chamber of that cannon.

It is upon ſuch ambiguous definitions and axioms as theſe that Spinoza has raiſed his pretended demonſtrations, that one ſubſtance cannot produce another; that every ſubſtance muſt neceſſarily be infinite; that no ſubſtance exiſts or can be conceived beſides God; and that extended ſubſtance or body is one of the infinite *attributes* of God. We ſhall not waſte our own time or the readers with a formal confutation of theſe impious abſurdities. We truſt they are ſufficiently confuted in other articles of this work (ſee METAPHYSICS, Part III. PROVIDENCE, and THEOLOGY, Part I.); and whoever wiſhes for a more particular examination of the author's principles, may find it in Dr Clarke's Demonſtration of the Being and Attributes of God. The truth, however, is, that no man will need the aſſiſtance of that eminent metaphyſician to diſcover the fallacy of the reaſoning by which they are attempted to be proved, if he affix *any one preciſe meaning* to the definitions and axioms, and adhere to that meaning ſteadily through the whole proceſs of the pretended demonſtrations.

By way of apology for this jargon, it has been lately ſaid, that "Spinoza takes the word *ſubſtance* in its moſt ſimple and perfect ſenſe; which is neceſſary, as he writes mathematically, and propoſes a ſimple idea as the foundation of his theory. What is the proper ſignification of a ſubſtance? Is it not that which ſtands alone, which has the cauſe of its exiſtence within itſelf? I wiſh that this ſimple meaning of the word could be univerſally admitted in philoſophy. Strictly ſpeaking, no worldly thing is a ſubſtance; ſince all mutually depend on each other, and finally on God, who, in this exalted ſenſe, is the only *ſubſtance*. The word *modification* ſounds harſh and improper, and therefore it cannot be expected to gain a place in philoſophy; but if the ſchool of Leibnitz may term matter the *appearance of ſubſtances*, why may not Spinoza be allowed a bolder term? Worldly ſubſtances are kept in union by divine power, as it was by divine power that they had exiſtence. They repreſent alſo, if you pleaſe, *modified* appearances of divine power; each according to the ſtation, the time, and the organs, in and with which it appears. The phraſe uſed by Spinoza is conciſe, and it gives an unity and ſimplicity to his whole ſyſtem, however ſtrange it may ſound in our ears."

Herder's Dialogues concerning God.

From this account of Spinoziſm, one who had never looked into the works of the author would be led to ſuppoſe that his ſyſtem is the ſame with that of Berkeley; which, denying the exiſtence of material ſubſtance, attributes all our perceptions of what we call the qualities of body to the immediate agency of the Deity on our minds (ſee METAPHYSICS, Part II. chap. 3.). But Spinoza's doctrine is very different. According to him, bodies are either attributes or affections of God; and as he ſays there is but one extended ſubſtance, he affirms that ſubſtance to be indiviſible, and employs a long ſcholium † to prove that thoſe are miſtaken who ſuppoſe it finite and not *eſſential to the Deity*. That we do not miſrepreſent his ſentiments, the learned reader will be convinced by the two following definitions, with which he introduces that part of his ethics which treats of the nature and origin of mind. 1. "Per corpus intelligo modum, qui Dei eſſentiam, quatenus, ut res extenſa conſideratur, certo et determinato modo exprimit." 2. "Ad eſſentiam alicujus rei id pertinere dico, quo dato res neceſſario ponitur, et quo ſublato res neceſſario tollitur; vel id, ſine quo res, et vice verſa quod ſine re nec eſſe nec concipi poteſt." In conformity with theſe definitions, he attempts to prove that God is an extended as well as a thinking ſubſtance; that as a thinking ſubſtance he is the cauſe of the *idea* of a circle, and as an extended ſubſtance of the *circle* itſelf; and that the minds of men are not ſubſtances, but certain modifications of the divine attributes; or, as he ſometimes expreſſes it. "Quod humanæ mentis actuale conſtituit, eſt idea rei ſingularis actu exiſtentis." Hence, he ſays, it follows that the human mind is a part of the intellect of the infinite God; ſo that when we ſpeak of the human mind perceiving this or that, we can only mean that God, not as he is infinite, but as he appears in the human mind or conſtitutes its eſſence, has this or that idea; and when we ſpeak of God's having this or that idea, we muſt conceive of Him not only as conſtituting the human mind, but as, together with it, having the idea of ſomething elſe (A). In another place he tells us, that the human mind is nothing but the *idea* which God has of the human body as actually exiſting; that this *idea* of the body, and the *body* itſelf, are one and the ſame thing; and that thinking and extended ſubſtances are in reality but one and the ſame ſubſtance, which is ſometimes comprehended under one attribute of the Deity, and ſometimes under another*.

† See his Prop. xv. &c.

Prop. vii. xi. Part ii.

* Prop. v. x. xiii. xxi. Part 2.

If this impious jargon be not Atheiſm, or as it has been ſometimes called Pantheiſm, we know not what it is (See PANTHEISM). According to Spinoſa, there is but one ſubſtance, which is extended, infinite, and indiviſible. That ſubſtance indeed he calls God; but he labours to prove that it is corporeal; that there is no difference between mind and matter; that both are attributes

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(A) Hinc ſequitur mentem humanam partem eſſe infiniti intellectus Dei; ac proinde cum dicimus, mentem humanam hoc vel illud percipere, nihil aliud dicimus quam quod Deus, non quatenus infinitus eſt, ſed quatenus per naturam humanæ mentis explicatur, ſive quatenus humanæ mentis eſſentiam conſtituit, hanc vel illam habet ideam et cum dicimus Deum hanc vel illam ideam habere, non tantum, quatenus naturam humanæ mentis conſtituit; ſed quatenus ſimul cum mente humana alterius rei etiam habet ideam. *Corol.* prop. xi. part 2.

Spinoza. tributes of the Deity variouſly conſidered; that the human ſoul is a part of the intellect of God; that the ſame ſoul is nothing but the idea of the human body; that this idea of the body, and the body itſelf, are one and the ſame thing; that God could not exiſt, or be conceived, were the viſible univerſe annihilated; and therefore that the viſible univerſe is either the one ſubſtance, or at leaſt an eſſential attribute or modification of that ſubſtance. He ſometimes indeed ſpeaks of the *power* of this ſubſtance; but when he comes to explain himſelf, we find that by power he means nothing but blind neceſſity *; and though he frequently talks of the *wiſdom* of God, he ſeems to make uſe of the word without meaning. This we think evident from the long appendix to his 36th propoſition; in which he labours to prove that the notion of final cauſes is an idle figment of the imagination, ſince, according to him, nothing but the prejudices of education could have led men to fancy that there is any real diſtinction between *good* and *evil*, *merit* and *demerit*, *praiſe* and *reproach*, *order* and *confuſion*; that *eyes* were given them that they might be enabled to *ſee*; *teeth* for the purpoſe of chewing their *food*; *herbs* and *animals* for the *matter* of that *food*; that the *ſun* was formed to give light, or the *ocean* to nouriſh *fiſhes*. If this be true, it is impoſſible to diſcover wiſdom in the operations of his *one ſubſtance*; ſince, in common apprehenſion, it is the very characteriſtic of folly to act without any end in view.

* Prop. xxxii. Part I.

Such are the reveries of that writer, whoſe works a German philoſopher of ſome name has lately recommended to the public, as calculated to convey to the mind more juſt and ſublime conceptions of God than are to be found in moſt other ſyſtems. The recommendation has had its effect. A literary journaliſt of our own, reviewing the volume in which it is given, feels a peculiar ſatisfaction from the diſcovery, that Spinoza, inſtead of a formidable enemy to the cauſe of virtue and religion, was indeed their warmeſt friend; and piouſly hopes that we ſhall become more cautious not to ſuffer ourſelves to be deceived by empty names, which thoſe who *cannot* reaſon (Sir Iſaac Newton and Dr Clarke perhaps) give to thoſe who can (Hobbes, we ſuppoſe, and Spinoza). But though we have the honour to think on this queſtion with our illuſtrious countrymen, we have no deſire to depict Spinoza as a *reprobate*, which the critic ſays has often been done by ignorance and enthuſiaſm. We admit that his conduct in active life was irreproachable; and for his ſpeculative opinions, he muſt ſtand or fall to his own Maſter. His Ethics appear to us indeed a ſyſtem ſhockingly impious; and in the tract intitled POLITICA, *power* and *right* are confounded as in the former volume; but in the treatiſe DE INTELLECTUS EMENDATIONE, are ſcattered many precepts of practical wiſdom, as well as ſome judicious rules for conducting philoſophical inveſtigation; and we only regret, that the reader muſt wade to them through pages of fataliſm, ſcepticiſm, and palpable contradictions. His *Compendium Grammatices Linguæ Hebrææ*, though left imperfect, appears to have ſo much merit, that it is to be wiſhed he had fulfilled his intention of writing a philoſophical grammar of that language, inſtead of waſting his time on abſtruſe ſpeculations, which though they ſeem not to have been injurious to his own virtue, are certainly not calculated to promote the virtue of others, or to increaſe the ſum of human happineſs.

Spiræa || Spirituous.

SPIRÆA, a genus of plants belonging to the claſs of icoſandria, and to the order of pentagynia; and in the natural ſyſtem arranged under the 26th order, *Pomaceæ*. See BOTANY *Index*.

SPIRAL, in *Geometry*, a curve line of the circular kind, which in its progreſs recedes from its centre.

SPIRE, in *Architecture*, was uſed by the ancients for the baſe of a column, and ſometimes for the aſtragal or tore; but among the moderns it denotes a ſteeple that continually diminiſhes as it aſcends, whether conically or pyramidally.

SPIRIT, in *Metaphyſics*, an incorporeal being or intelligence; in which ſenſe God is ſaid to be a ſpirit, as are angels and the human ſoul. See METAPHYSICS, Part III.

SPIRIT, in *Chemiſtry* and *Pharmacy*, a name applied to every volatile liquid which is not inſipid like phlegm or water; and hence the diſtinction into acid, alkaline, and vinous ſpirits.

SPIRIT of Wine. See ALCOHOL, CHEMISTRY *Index*; DISTILLATION, and MATERIA MEDICA *Index*.

SPIRITS, or ANIMAL SPIRITS. See ANATOMY, Part V. n° 136.

SPIRITUAL, in general, ſomething belonging to or partaking of the nature of ſpirit. See SPIRIT.

SPIRITUOUS LIQUORS have in all nations been conſidered as a proper ſubject of heavy taxation for the ſupport of the ſtate. This has naturally occaſioned a nice examination of their ſtrength. It having been at laſt found that this was intimately connected with the ſpecific gravity, this has been examined with the moſt ſcrupulous attention to every circumſtance which could affect it, ſo that the duties might be exactly proportioned to the quantity of ſpirit in any ſtrong liquor, independent on every other circumſtance of flavour or taſte, or other valued quality. The chemiſt at laſt found that the baſis of all ſtrong liquors is the ſame, produced by the vinous fermentation of pure ſaccharine matter diſſolved in water. He alſo found, that whether this vegetable ſalt be taken as it is ſpontaneouſly formed in the juices of plants and fruits, or as it may be formed or extricated from farinaceous fruits and roots by a certain part of the proceſs of vegetation, it produces the ſame ardent ſpirit, which has always the ſame denſity in every mixture with water. The minute portions of aromatic oils, which are in ſome degree inſeparable from it, and give it a different flavour according to the ſubſtance from which it was obtained, are not found to have any ſenſible effect on its denſity or ſpecific gravity. This ſeems very completely eſtabliſhed in conſequence of the unwearied attempts of the manufacturers to leſſen the duties payable on their goods by mixtures of other ſubſtances, which would increaſe their denſity without making them leſs palatable. The vigilance of the revenue officers was no leſs employed to detect every ſuch contrivance. In ſhort, it is now an acknowledged point, that the ſpecific gravity is an accurate teſt of the ſtrength.

But though this is true in general, we cannot derive much benefit from it, unleſs we know the preciſe relation between the ſtrength and the denſity of a ſpirituous liquor. Do they increaſe *pari paſſu*, or by what law

law are they connected? It was natural to expect that equal additions of ardent spirits or alcohol to a given quantity of water would produce equal diminutions of density. Areometers were accordingly made on this principle above 200 years ago, as may be seen in the works of Gaspar Schottus, Sturmius, Agricola, and other old authors. But when mathematical physics became more generally known, this was easily discovered to be erroneous; and it was shown (we think first by Mr Boyle) that equal additions to the specific gravity would be produced by successively taking out of any vessel a certain measure of alcohol and replacing it with an equal measure of water. This was the most convenient discovery for all parties, because then the duties payable on a cask of spirits would be in the exact proportion of the diminution of its density. But it was soon found by those who were appointed guardians of the revenue that this conclusion was erroneous, and that a mixture which appeared by this rule to contain 35 gallons of alcohol, did really contain $35\frac{1}{4}$. This they found by actually making such a mixture: 18 gallons of alcohol mixed with 18 of water produced only 35 gallons of spirits. The revenue officers, finding that this condensation was most remarkable in mixtures of equal parts of water and the strongest spirits which could then be procured, determined to levy the duties by this mixture; because, whether the spirituous liquor was stronger or weaker than this, it would appear, by its specific gravity, rather stronger than it really was. This sagacious observation, and the simplicity of the composition, which could at all times be made for comparison, seem to be the reasons for our excise offices selecting this mode of estimating the strength and levying the duties. A mixture of nearly equal measures of water and alcohol is called PROOF SPIRIT, and pays a certain duty per gallon; and the strength of a spirituous liquor is estimated by the gallons, not of alcohol, but of proof spirit which the cask contains. But because it might be difficult to procure at all times this proof spirit for comparison, such a mixture was made by order of the board of excise: and it was found, that when six gallons of it was mixed with one gallon of water, a wine gallon of the mixture weighed 7 pounds 13 ounces avoirdupois. The board therefore declared, that the spirituous liquor of which the gallon weighed 7 pounds 13 ounces should be reckoned 1 to 6 or 1 in 7 under proof. This is but an aukward and complex formula; it was in order to suit matters to a mode of examination which had by time obtained the sanction of the board. Mr Clarke, an ingenious artist of that time, had made a hydrometer incomparably more exact than any other, and constructed on mathematical principles fit for computation. This had a set of weights corresponding to the additions of water or proof spirit, and the mixture 1 to 6 or 1 in 7 was the only one which weighed an exact number of ounces per gallon without a fraction.

Thus stands the excise law; and Clarke's hydrometer is still the instrument of authority, although others have been since constructed by DICAS, QUIN, and others, which are much more ingenious and convenient. The mathematician who examines Dicas's hydrometer, with its sliding scale, by which it is adjusted to the different temperatures, and points out the condensations, will perceive a beautiful and sagacious combination of quantities, which he will find it difficult to bring under any analytical formula. Perhaps Quin's may have some preference in respect of conveniency; but *facile inventis addere*. Mr Dicas's was original (A).

As naturalists became more accustomed to exact observations in every topic of inquiry, the condensation which obtains in the mixture of different substances became more familiarly known. This evidently affects the present question; and both the excise and the distillers are interested in its accurate decision. This occasioned an application to the Royal Society; and a most scrupulous examination of the strength of spirituous liquors was made by Sir Charles Blagden and Mr Gilpin, of which they have given a very particular account in the Philosophical Transactions for 1790 and 1792.

We have taken notice of this in the article SPECIFIC GRAVITY, mentioning such circumstances of the results as suited our purposes of physical discussion. At present

(A) Among the various contrivances which have been thought of, among manufacturers and dealers, as well as for the purposes of revenue, for ascertaining the specific gravity, and consequently the real strength and value of high-priced and high-taxed liquids, we are persuaded there is none equal, in point of accuracy, simplicity, and facility of application, to the areometrical beads lately announced to the public by Mrs Lovi of Edinburgh, under the privilege of a patent; and with this persuasion we have no hesitation in recommending them to those to whom the use of a simple and accurate instrument is of great importance in determining the value of high-priced spirituous liquors. Our recommendation rests not solely on our own opinion, but is supported by that of others who are well acquainted with such subjects. We know, too, that the beads have been examined and compared by several intelligent manufacturers and dealers with some of the most accurate hydrometrical instruments, and after a fair trial, a decided preference has been given to the beads. The whole apparatus consists of 30 beads, a sliding rule, a thermometer, a glass jar and brass hook, which are packed in a neat small box; and it is accompanied with directions, which point out, 1. In what manner the real strength of spirits may be ascertained at any given temperature between 40° and 80°. 2. How much per cent. the spirit to be tried is over or under proof according to the practice of spirit dealers; and, 3. The proportion of water and the strongest spirits or alcohol, according to the views and language of excisemen. The advantages of these beads are, that being made of a substance which is little acted on by chemical agents, they are less liable to be injured by use, than instruments composed of metal; and when a bead happens to be broken, it can be easily replaced. They possess this farther advantage, that with the application of the thermometer, and the calculation of the sliding rule, the real strength of the spirits may be taken at all temperatures. It has been suggested, that these beads, from their being less liable to change than other instruments, might be usefully employed in checking the errors and variations of other hydrometers. Beads are prepared by Mrs Lovi on the same principle for ascertaining the strength of worts, acids, &c.

fent we give the general refult in the table of fpecific gravity, as peculiarly belonging to fpirituous liquors, affording the moft exact account of their denfity in every ftate of dilution of alcohol with water. And as the relation between the proportion of ingredients and the denfity is peculiar to every fubftance, fo that fcarcely any inference can be made from one to another, the reader will confider the tables here given as characteriftic with refpect to alcohol. In all folutions of falts we found that the condenfation increafes continually with the dilution, whereas it is greateft when equal bulks of water and alcohol are mixed; yet we do not confider this as an exception; for it is certain, that in the ftrongeft brine the faline ingredient bears but a fmall proportion to the water—and when we mix two folutions, the condenfation is greateft when they are nearly equal in bulk. But we think ourfelves entitled to infer, that alcohol is not a dilution of a fubftance in a quantity of water; but that water, in a certain proportion, not very diftant from what we can produce by flow diftillation, is an ingredient of alcohol, or is one of its component parts, and not merely a vehicle or menftruum. We therefore imagine that proof fpirit contains nearly equal bulks of water and ardent fpirits.

The great difficulty in this examination arofe from the very diffimilar expanfions of water and alcohol by heat. This determined Sir Charles Blagden to eftimate the proportions of ingredients by weight, and made it abfolutely neceffary to give a fcale of fpecific gravity and ftrength for every temperature. For it muft be remarked, that the queftion (whether in commerce or philofophy) always is, "How many gallons of alcohol and of water, taken juft now and mixed together, will produce a hundred gallons of the fpirit we are examining?" The proportion of thefe two will be different according to the temperature of both. As many mixtures therefore muft have been made in each proportion as there were temperatures confidered; but by taking the ingredients by weight, and examining the denfity of the compound in one temperature, it is then heated and cooled, and its change of denfity obferved. Calculation then can tell us the change in the proportion of the bulks or numbers of gallons in the mixture, by means of a previous table fhowing the expanfions of water and of alcohol.

The alcohol felected for this examination had the fpecific gravity 0.825. This is not the pureft that can be procured; fome was produced of 0.816, of 0.814, and 0.813, both obtained from rum, from brandy, and from malt fpirit. We are informed that Dr Black has obtained it of the fpecific gravity 0.8 by digefting alcohol with fixed ammoniac (muriatic acid united with lime) made very dry. It dephlegmates alcohol very powerfully without decompofing it, which always happens when we ufe cauftic alkali. Alcohol of 0.825 was chofen becaufe expreffed by a number of eafy management in computation.

The examination commenced by afcertaining the expanfions of water and alcohol. The temperature 60° of Fahrenheit's fcale was felected for the general temperature of comparifon, being eafily attainable even in cold weather, and allowing the examinator to operate at eafe. The firft and laft compartments of the tables contain the weights and fpecific gravities of alcohol and water for every fifth degree of heat from 30° to 100°. From thefe we have conftructed the two following little tables of expanfion. The bulk of 1000 ounces, pounds, or other weight of water and of alcohol of the temperature 60°, occupies the bulks expreffed in the tables for every other temperature. Water could not be eafily or ufefully examined when of the temperature 30°, becaufe it is with great difficulty kept fluid in that temperature. It is very remarkable, that when it can be fo kept, it expands inftead of contracting; while cooling down from 35° or thereabouts, and as it approaches to 32°, it expands rapidly. We obferve the fame thing in the cryftallization of Glauber falt, martial vitriol, and fome others, which contain much water in their cryftals. We obferve, on the other hand, a remarkable contraction in the zeolite juft before its beginning to fwell into bubbles by a red heat.

Heat.	Bulk of 100,000 ounces.			
	Of Water		Of Alcohol.	
		Diff.		Diff.
30°			119195	
35	99910		119514	319
40	99906	— 4	119839	325
45	99914	+ 8	120172	332
50	99932	18	120514	342
55	99962	30	120868	348
60	100000	38	121122	350
65	100050	50	121565	353
70	100106	56	121919	354
75	100170	64	122279	360
80	100241	71	122645	366
85	100320	79	123017	372
90	100404	84	123393	376
95	100500	96	123773	380
100	100608	108	124157	384

This being premifed, the examination was conducted in the following manner. It was determined to mix 100 parts by weight of pure alcohol with five, ten, fifteen, twenty, parts of diftilled water, till they were compounded in equal quantities, and then to mix 100 parts of diftilled water with, 95, 90, 85, 80, &c. parts of alcohol, till they were mixed in the proportion of 100 to 5. Thus a feries of mixtures would be obtained, extending from pure alcohol to pure water. This feries would be fuch, that the examinations would be moft frequent in the cafes moft ufual in the commerce of ftrong liquors. A fet of phials, fitted with ground ftoppers, were provided, of fizes fit to hold the intended mixtures. Thefe mixtures were made by fufpending the phial to the arm of a very nice balance, in the oppofite fcale of which (befides the counterpoife of the phial) there was placed the weight 100. Spirit was then poured into the phial till it exactly balanced the weight 100. The weight for the water to be added was then put into the oppofite fcale, and water was poured into the phial by means of a flender glafs funnel, by fmall quantities at a time, and the phial frequently agitated to promote the mixture. When the additional weight was exactly balanced, the phial was taken off, its ftopper put in, and leather tied over it, and it was fet by, for at leaft a month, that the mixture and the whole procefs of condenfation might be completed. The fame method

method was followed in the mixtures where the water was predominant.

When the ingredients of thefe mixtures were judged to have completely incorporated, their fpecific gravity was examined by weighing with the moft fcrupulous precifion the contents of a veffel which held 2925 troy grains of water, of the temperature 60°. The balance was fo exceedingly fenfible, that the 50th part of a grain greatly deranged its pofition when loaded with the fcales and their contents. It was conftructed by Mr Ramfden, and fome account of its exquifite fenfibility may be feen in the *Journal de Phyfique*, vol. xxxiii. This quantity of materials was therefore thought abundantly fufficient for afcertaining the denfity of the liquor. It is needlefs to detail the precautions which were taken for having the contents of the weighing bottle brought to the precife temperature proper for the experiment. They were fuch as every perfon converfant with fuch things is accuftomed to take.—The bottle had a flender neck, and being put on a lathe, a mark was made round it with a diamond. The bottle was filled till the bottom of the hollow furface of the fluid was in the plane of this mark; and to judge of the accuracy attainable in filling the bottle, the operation was feveral times repeated and the contents weighed, without the difference of $\frac{1}{30}$th of a grain in 2925. The only fource of error which was to be guarded againft was air-bubbles adhering to the infide of the bottle, or moifture condenfing (in the experiments with low temperatures) on the outfide. Both of thefe were attended to as much as poffible.

This method of determining the fpecific gravity was preferred to the ufual method, obferving the weight loft by a lump of glafs when fufpended in water; for Mr Gilpin had been enabled, by means of this nice balance, to difcover, even in pure water and in alcohol, a want of perfect fluidity. Something like vifcidity rendered the motion of a lump of glafs through the liquor fenfibly fluggifh, fo that when the balance was brought to a level, there was not a perfect equilibrium of weights: (See what we have faid of this matter in SPECIFIC GRAVITY). Mr Gilpin alfo tried the ingenious inftrument propofed for fuch experiments by Mr Ramfden, and defcribed by him in a pamphlet on this very fubject; and he found the anomalies of experiment much greater than in this method by weighing.—Indeed the regular progreffion of weights to be feen in the annexed tables is an unqueftionable proof of the fufficiency of the method; and it has the evident advantage of all other methods in point of fimplicity and practicability without any uncommon apparatus. Any perfon poffeffed of a good ordinary balance and a fet of exact weights may examine all queftions of this kind, by weighing pure water and the liquor which he may have occafion to examine in a common 6 or 8 ounce phial. For this reafon, it is recommended (in preference to all hydrometers) to the board of excife to provide this fimple apparatus in every principal office.

Every experiment was made at leaft three times; and the mean refult (which never differed one grain from the extreme) was taken.

From thefe experiments the annexed tables were conftructed. The firft is the fimple abftract of the experiments, containing the weights of the contents of the bottle of every mixture. The fecond contains the fpecific gravities deduced from them.

We have faid that the experiments appear furprifingly accurate. This we fay on the authority of the regular progreffion of the fpecific gravity in any of the horizontal rows. In the feries, for inftance, for the temperature 60°, the greateft anomaly is in the mixture of 50 parts of fpirit with 100 of water. The fpecific gravity is 95804, wanting 3 or 4 of the regular progreffion. This does not amount to 1 in 18000.

TABLE I. Weights at the different Degrees of Temperature.

Heat.	The pure Spirit.	100 grains of spirit to 5 grains of water.	100 grains of spirit to 10 grains of water.	100 grains of spirit to 15 grains of water.	100 grains of spirit to 20 grains of water.	100 grains of spirit to 25 grains of water.	100 grains of spirit to 30 grains of water.	100 grains of spirit to 35 grains of water.	100 grains of spirit to 40 grains of water.	100 grains of spirit to 45 grains of water.	100 grains of spirit to 50 grains of water.	100 grains of spirit to 55 grains of water.	100 grains of spirit to 60 grains of water.	100 grains of spirit to 65 grains of water.
deg.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.
30	2487.35	2519.92	2548.42	2573.80	2596.66	2617.30	2636.23	2653.73	2669.83	2684.74	2698.51	2711.14	2722.89	2733.87
35	2480.87	2513.43	2541.84	2567.26	2590.16	2610.87	2629.92	2647.47	2663.64	2678.60	2692.43	2705.14	2716.92	2727.87
40	2474.30	2506.75	2535.41	2560.74	2583.66	2604.50	2623.56	2641.08	2657.23	2672.30	2686.32	2698.94	2710.81	2721.83
45	2467.62	2500.14	2528.75	2554.09	2577.10	2597.98	2617.03	2634.64	2650.87	2666.04	2679.99	2692.77	2704.57	2715.62
50	2460.[illegible]	2493.33	2521.96	2547.47	2570.42	2591.38	2610.54	2628.21	2644.43	2659.55	2673.64	2686.54	2698.42	2709.48
55	2453.80	2486.37	2515.03	2540.60	2563.64	2584.65	2603.80	2621.50	2637.86	2653.04	2667.14	2679.98	2691.83	2702.98
60	2447.00	2479.56	2508.27	2533.83	2556.90	2577.95	2597.22	2615.03	2631.37	2646.53	2660.62	2673.55	2685.52	2696.73
65	2440.12	2472.75	2501.53	2526.99	2550.22	2571.24	2590.55	2608.37	2624.75	2640.01	2654.04	2667.07	2679.15	2690.32
70	2433.23	2465.88	2494.56	2520.03	2543.32	2564.47	2583.88	2601.67	2617.96	2633.32	2647.52	2660.63	2672.74	2684.02
75	2426.23	2458.78	2487.62	2513.08	2536.39	2557.61	2576.93	2594.80	2611.19	2626.55	2640.81	2653.99	2666.06	2677.34
80	2419.02	2451.67	2480.45	2506.08	2529.24	2550.50	2569.86	2587.93	2604.29	2619.72	2633.99	2647.12	2659.36	2670.69
85	2411.92	2444.63	2473.33	2499.01	2522.29	2543.54	2563.01	2580.93	2597.45	2613.02	2627.39	2640.60	2652.78	2664.16
90	2404.90	2437.62	2466.32	2491.99	2515.28	2536.63	2556.11	2574.02	2590.60	2606.16	2620.52	2633.74	2646.00	2657.41
95	2397.68	2430.33	2459.13	2484.74	2508.10	2529.46	2549.13	2567.03	2583.65	2599.24	2613.57	2626.94	2639.25	2650.63
100	2390.60	2423.22	2452.13	2477.64	2500.91	2522.30	2541.92	2559.96	2576.56	2592.14	2606.50	2619.75	2632.17	2643.75

Heat.	100 grains of spirit to 70 grains of water.	100 grains of spirit to 75 grains of water.	100 grains of spirit to 80 grains of water.	100 grains of spirit to 85 grains of water.	100 grains of spirit to 90 grains of water.	100 grains of spirit to 95 grains of water.	100 grains of spirit to 100 grains of water.	95 grains of spirit to 100 grains of water.	90 grains of spirit to 100 grains of water.	85 grains of spirit to 100 grains of water.	80 grains of spirit to 100 grains of water.	75 grains of spirit to 100 grains of water.	70 grains of spirit to 100 grains of water.	65 grains of spirit to 100 grains of water.
deg.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.
30	2744.20	2753.75	2762.72	2771.08	2778.99	2786.36	2793.22	2799.85	2806.61	2813.85	2821.35	2828.90	2836.39	2844.16
35	2738.13	2747.74	2756.91	2765.32	2773.22	2780.59	2787.54	2794.19	2801.14	2808.52	2816.07	2823.68	2831.36	2839.26
40	2732.24	2741.86	2750.96	2759.50	2767.48	2774.90	2781.84	2788.69	2795.70	2803.17	2810.73	2818.36	2826.31	2834.40
45	2726.09	2735.77	2744.82	2753.36	2761.42	2768.85	2775.94	2782.99	2789.99	2797.45	2805.08	2812.93	2821.00	2829.28
50	2719.93	2729.64	2738.74	2747.27	2755.37	2762.95	2770.14	2777.19	2784.30	2791.72	2799.58	2807.56	2815.71	2824.12
55	2713.60	2723.51	2732.64	2741.24	2749.27	2756.83	2764.09	2771.29	2778.54	2785.96	2793.82	2801.89	2810.23	2818.80
60	2707.40	2717.30	2726.52	2735.17	2743.28	2750.93	2758.17	2765.40	2772.70	2780.26	2788.25	2796.45	2804.85	2813.65
65	2701.05	2710.96	2720.25	2728.98	2737.09	2744.86	2752.21	2759.47	2766.73	2774.43	2782.62	2790.81	2799.38	2808.31
70	2694.76	2704.64	2713.87	2722.75	2730.94	2738.73	2746.06	2753.41	2760.75	2768.45	2776.72	2785.06	2793.80	2802.88
75	2688.14	2698.07	2707.49	2716.35	2724.64	2732.39	2739.89	2747.23	2754.73	2762.58	2770.93	2779.26	2788.00	2797.21
80	2681.50	2691.50	2700.94	2709.76	2718.12	2726.06	2733.53	2740.93	2748.42	2756.43	2764.87	2773.33	2782.14	2791.52
85	2674.95	2684.98	2694.53	2703.33	2711.86	2719.74	2727.25	2734.80	2742.31	2750.22	2758.80	2767.44	2776.33	2785.81
90	2668.29	2678.49	2687.99	2696.91	2705.37	2713.32	2721.01	2728.59	2736.23	2744.24	2752.76	2761.51	2770.59	2780.11
95	2661.51	2671.82	2681.34	2690.33	2698.86	2706.88	2714.61	2722.23	2729.89	2737.98	2746.57	2755.34	2764.57	2774.25
100	2654.76	2664.99	2674.62	2683.63	2692.25	2700.33	2708.04	2715.73	2723.35	2731.55	2740.43	2749.28	2758.48	2768.43

Heat.	60 grains of spirit to 100 grains of water.	55 grains of spirit to 100 grains of water.	50 grains of spirit to 100 grains of water.	45 grains of spirit to 100 grains of water.	40 grains of spirit to 100 grains of water.	35 grains of spirit to 100 grains of water.	30 grains of spirit to 100 grains of water.	25 grains of spirit to 100 grains of water.	20 grains of spirit to 100 grains of water.	15 grains of spirit to 100 grains of water.	10 grains of spirit to 100 grains of water.	5 grains of spirit to 100 grains of water.	Water.
deg.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.
30	2852.03	2859.71	2867.12	2874.43	2881.34	2887.77	2894.22	2900.85	2908.21	2917.19	2928.80	2944.53	
35	2847.45	2855.32	2863.16	2870.87	2878.21	2885.06	2892.07	2899.31	2907.45	2916.95	2928.99	2945.02	2967.14
40	2842.62	2850.88	2859.06	2867.08	2874.81	2882.30	2889.78	2897.61	2906.39	2916.41	2928.93	2945.25	2967.45
45	2837.64	2846.16	2854.67	2863.04	2871.22	2879.22	2887.33	2895.67	2904.98	2915.55	2928.49	2945.20	2967.40
50	2832.76	2841.52	2850.29	2858.96	2867.52	2875.98	2884.57	2893.58	2903.39	2914.42	2927.81	2944.73	2967.05
55	2827.68	2836.69	2845.72	2854.75	2863.75	2872.67	2881.69	2891.11	2901.42	2913.02	2926.73	2943.98	2966.34
60	2822.65	2831.90	2841.10	2850.50	2859.87	2869.15	2878.72	2888.62	2899.35	2911.32	2925.50	2942.98	2965.39
65	2817.49	2826.90	2836.30	2845.97	2855.65	2865.45	2875.49	2885.85	2897.09	2909.43	2923.90	2941.69	2964.11
70	2812.16	2821.78	2831.61	2841.42	2851.53	2861.63	2872.06	2882.90	2894.56	2907.33	2922.24	2940.13	2962.66
75	2806.75	2816.63	2826.56	2836.80	2847.14	2857.70	2868.49	2879.67	2891.79	2905.04	2920.17	2938.33	2960.97
80	2801.25	2811.23	2821.38	2831.92	2842.56	2853.38	2864.54	2876.22	2888.73	2902.35	2917.83	2936.31	2959.07
85	2795.69	2805.85	2816.32	2827.12	2838.07	2849.28	2860.86	2872.88	2885.56	2899.55	2915.46	2934.14	2956.94
90	2790.13	2800.40	2811.05	2822.15	2833.38	2844.81	2856.80	2869.16	2882.25	2896.58	2912.84	2931.77	2954.70
95	2784.36	2794.91	2805.79	2817.08	2828.46	2840.26	2852.47	2865.15	2878.71	2898.44	2910.02	2929.15	2952.08
100	2778.64	2789.32	2800.25	2811.80	2823.55	2835.30	2848.18	2861.12	2875.07	2890.04	2906.97	2926.28	2949.34

TABLE

TABLE II. Real Specific Gravities at the different Temperatures.

Heat.	The pure spirit.	100 grains of spirit to 5 grains of water.	100 grains of spirit to 10 grains of water.	100 grains of spirit to 15 grains of water.	100 grains of spirit to 20 grains of water.	100 grains of spirit to 25 grains of water.	100 grains of spirit to 30 grains of water.	100 grains of spirit to 35 grains of water.	100 grains of spirit to 40 grains of water.	100 grains of spirit to 45 grains of water.	100 grains of spirit to 50 grains of water.	100 grains of spirit to 55 grains of water.	100 grains of spirit to 60 grains of water.	100 grains of spirit to 65 grains of water.
deg.														
30	.83896	.84995	.85957	.86825	.87585	.88282	.88921	.89511	.90054	.90558	.91023	.91449	.91847	.92217
35	.83672	.84769	.85729	.86587	.87357	.88059	.88701	.89294	.89839	.90345	.90811	.91241	.91640	.92009
40	.83445	.84539	.85507	.86361	.87134	.87838	.88481	.89073	.89617	.90127	.90596	.91026	.91428	.91799
45	.83214	.84310	.85277	.86131	.86907	.87613	.88255	.88849	.89396	.89909	.90380	.90812	.91211	.91584
50	.82977	.84076	.85042	.85902	.86676	.87384	.88030	.88626	.89174	.89684	.90160	.90596	.90997	.91370
55	.82736	.83834	.84802	.85664	.86441	.87150	.87796	.88393	.88945	.89458	.89933	.90367	.90768	.91144
60	.82500	.83599	.84568	.85430	.86208	.86918	.87568	.88169	.88720	.89232	.89707	.90144	.90549	.90927
65	.82262	.83362	.84334	.85193	.85976	.86686	.87337	.87938	.88490	.89006	.89479	.89920	.90328	.90707
70	.82023	.83124	.84092	.84951	.85736	.86451	.87105	.87705	.88254	.88773	.89252	.89695	.90104	.90484
75	.81780	.82878	.83851	.84710	.85493	.86212	.86864	.87466	.88018	.88538	.89018	.89464	.89872	.90252
80	.81530	.82631	.83603	.84467	.85248	.85966	.86623	.87228	.87776	.88301	.88781	.89225	.89639	.90021
85	.81283	.82386	.83355	.84221	.85006	.85723	.86380	.86984	.87541	.88067	.88551	.88998	.89409	.89793
90	.81039	.82142	.83111	.83977	.84762	.85483	.86139	.86743	.87302	.87827	.88312	.88758	.89173	.89558
95	.80788	.81888	.82860	.83724	.84511	.85232	.85896	.86499	.87060	.87586	.88069	.88521	.88937	.89322
100	.80543	.81643	.82618	.83478	.84262	.84984	.85646	.86254	.86813	.87340	.87824	.88271	.88691	.89082

Heat.	100 grains of spirit to 70 grains of water.	100 grains of spirit to 75 grains of water.	100 grains of spirit to 80 grains of water.	100 grains of spirit to 85 grains of water.	100 grains of spirit to 90 grains of water.	100 grains of spirit to 95 grains of water.	100 grains of spirit to 100 grains of water.	95 grains of spirit to 100 grains of water.	90 grains of spirit to 100 grains of water.	85 grains of spirit to 100 grains of water.	80 grains of spirit to 100 grains of water.	75 grains of spirit to 100 grains of water.	70 grains of spirit to 100 grains of water.	65 grains of spirit to 100 grains of water.
deg.														
30	.92563	.92889	.93191	.93474	.93741	.93991	.94222	.94447	.94675	.94920	.95173	.95429	.95681	.95944
35	.92355	.92680	.92986	.93274	.93541	.93790	.94025	.94249	.94484	.94734	.94988	.95246	.95502	.95772
40	.92151	.92476	.92783	.93072	.93341	.93592	.93827	.94058	.94295	.94547	.94802	.95060	.95328	.95602
45	.91937	.92264	.92570	.92859	.93131	.93382	.93621	.93860	.94096	.94348	.94605	.94871	.95143	.95423
50	.91723	.92050	.92358	.92647	.92919	.93177	.93419	.93658	.93897	.94149	.94414	.94683	.94958	.95243
55	.91502	.91837	.92145	.92436	.92707	.92963	.93208	.93452	.93696	.93948	.94213	.94486	.94767	.95057
60	.91287	.91622	.91933	.92225	.92499	.92758	.93002	.93247	.93493	.93749	.94018	.94296	.94579	.94876
65	.91066	.91400	.91715	.92010	.92283	.92546	.92794	.93040	.93285	.93546	.93822	.94099	.94388	.94689
70	.90847	.91181	.91493	.91793	.92069	.92333	.92580	.92828	.93076	.93337	.93616	.93898	.94193	.94500
75	.90617	.90952	.91270	.91569	.91849	.92111	.92364	.92613	.92865	.93132	.93413	.93695	.93989	.94301
80	.90385	.90723	.91042	.91340	.91622	.91891	.92142	.92393	.92646	.92917	.93201	.93488	.93785	.94102
85	.90157	.90496	.90818	.91119	.91403	.91670	.91923	.92179	.92432	.92700	.92989	.93282	.93582	.93902
90	.89925	.90270	.90590	.90891	.91177	.91446	.91705	.91962	.92220	.92491	.92779	.93075	.93381	.93703
95	.89688	.90037	.90358	.90662	.90949	.91221	.91481	.91740	.91998	.92272	.92562	.92858	.93170	.93497
100	.89453	.89798	.90123	.90428	.90718	.90992	.91252	.91513	.91769	.92047	.92346	.92646	.92957	.93293

Heat.	60 grains of spirit to 100 grains of water.	55 grains of spirit to 100 grains of water.	50 grains of spirit to 100 grains of water.	45 grains of spirit to 100 grains of water.	40 grains of spirit to 100 grains of water.	35 grains of spirit to 100 grains of water.	30 grains of spirit to 100 grains of water.	25 grains of spirit to 100 grains of water.	20 grains of spirit to 100 grains of water.	15 grains of spirit to 100 grains of water.	10 grains of spirit to 100 grains of water.	5 grains of spirit to 100 grains of water.	Water.
deg.													
30	.96209	.96470	.96719	.96967	.97200	.97418	.97635	.97860	.98108	.98412	.98804	.99334	
35	.96048	.96315	.96579	.96840	.97086	.97319	.97556	.97801	.98076	.98397	.98804	.99344	1.00090
40	.95879	.96159	.96434	.96706	.96967	.97220	.97472	.97737	.98033	.98373	.98795	.99345	1.00094
45	.95705	.95993	.96280	.96563	.96840	.97110	.97384	.97666	.97980	.98338	.98774	.99338	1.00086
50	.95534	.95831	.96126	.96420	.96708	.96995	.97284	.97589	.97920	.98293	.98745	.99316	1.00068
55	.95357	.95662	.95966	.96272	.96575	.96877	.97181	.97500	.97847	.98239	.98702	.99284	1.00038
60	.95181	.95493	.95804	.96122	.96437	.96752	.97074	.97409	.97771	.98176	.98654	.99244	1.00000
65	.95000	.95318	.95635	.95962	.96288	.96620	.96959	.97309	.97688	.98106	.98594	.99194	.99950
70	.94813	.95139	.95469	.95802	.96143	.96484	.96836	.97203	.97596	.98028	.98527	.99134	.99894
75	.94623	.94957	.95292	.95638	.95987	.96344	.96708	.97086	.97495	.97943	.98454	.99066	.99830
80	.94431	.94768	.95111	.95467	.95826	.96192	.96568	.96963	.97385	.97845	.98367	.98991	.99759
85	.94236	.94579	.94932	.95297	.95667	.96046	.96437	.96843	.97271	.97744	.98281	.98912	.99681
90	.94042	.94389	.94748	.95123	.95502	.95889	.96293	.96711	.97153	.97637	.98185	.98824	.99598
95	.93839	.94196	.94563	.94944	.95328	.95727	.96139	.96568	.97025	.97523	.98082	.98729	.99502
100	.93638	.93999	.94368	.94759	.95152	.95556	.95983	.96424	.96895	.97401	.97969	.98625	.99402

We formerly obferved, that the feries of mixtures chofen by Sir Charles Blagden, for the advantages attending it in making the experiment, was not fuited for folving the queftions which commonly occur in the fpirit bufinefs. He accordingly fuggelts the propriety of forming tables in a convenient feries from the data furnifhed by thefe experiments, indicating the proportion of ingredients contained in fome conftant weight or bulk.

To facilitate the conftruction of fuch tables, it is neceffary to confider the fubject in the moft general manner. Therefore let a reprefent the conftant number 100. Let w and s reprefent the quantities of water and fpirit by weight in any mixture; that is, the pounds, ounces, or grains of each. Let x reprefent the quantity per cent. of fpirits alfo by weight; that is, the number of pounds of fpirits contained in 100 pounds of the mixture; and let y be its quantity per cent. in gallons, or the number of gallons contained in 100 gallons of the unmixed ingredients. Let m be the bulk of a pound of fpirit of any given temperature, the bulk of a pound of water *of the fame temperature* being accounted 1.

Then $w+s$ is the weight of any mixture, and $w+ms$ is its bulk.

We have the following proportions: 1. $w+s:s=a:x$, and $x=\frac{as}{w+s}$ (Equation 1ft); and hence s may be found when x the per centage in weight is given, for $s=\frac{wx}{a-x}$ (Equation 2.)

2. $w+ms:ms=a:y$, and $y=a\frac{ms}{w+ms}$ (Equation 3d); and s may be found when y, the per centage in gallons, is given; for $s=\frac{my}{a-y}$ (Equation 4th).

The ufual queftions which can be folved from thefe experiments are,

1. To afcertain the quantity of fpirits per cent. in bulk from obfervation of the fpecific gravity, or to tell how many gallons of fpirit are in 100 gallons of mixture.

Look for the fpecific gravity in the table, and at the head of the column will be found the w and s correfponding. If the precife fpecific gravity obferved is not in the tables, the s muft be found by interpolation. And here it is proper to remark, that taking the fimple proportional parts of fpecific gravity will not be fufficiently exact, efpecially near the beginning or the end of the table, becaufe the denfities correfponding to the feries of mixtures do not change uniformly. We muft have recourfe to the general rules of interpolation, by means of firft and fecond differences, or be provided with a fubfidiary table of differences. A good deal of practice in computations of this kind fuggefted the following method of making fuch interpolations with great difpatch and abundant accuracy. On a plate of wood or metal, or ftiff card-paper, draw a line EF (fig. 1.), as a fcale of equal parts, reprefenting the leading or equable arithmetical feries of any table. (In the prefent cafe EF is the fcale on which s is computed.)—Through every point of divifion draw the perpendiculars BA, EC, FD, &c. Make one of them AB more confpicuous than the reft, and diftinguifh the others alfo in fuch fort, that the eye fhall readily catch their diftance from the principal line AB. Let GPL be a thin flip of whalebone, of uniform breadth and thicknefs, alfo divided into equal parts properly diftinguifhable. Laftly, let there be a pin P fixed near the middle of the principal line AB.

Plate CCCCXCIX Fig. 1.

Now fuppofe that a value of s is to be interpolated by means of an obferved fpecific gravity not in the table. Look for the neareft to it, and note its diftance from the preceding and the following. Let thefe be PH and PK on the flexible fcale. Alfo take notice of the lines K 10 and H 10, whofe diftances from AB are equal to the conftant difference between the fucceffive values of S, or to any eafily eftimated multiple of it (as in the prefent cafe we have taken 10 and 10, inftead of 5 and 5, the running difference of Sir Charles Blagden's table). Then, leaning the middle point P of the whalebone on the pin P in the board, bend it, and place it flantwife till the points K and H fall fomewhere on the two parallels K 10 and H 10. No matter how oblique the pofition of the whalebone is. It will bend in fuch a manner that its different points of divifion (reprefenting different fpecific gravities) will fall on the parallels which reprefent the correfponding values of s. We can fay that all this may be done in lefs than half a minute, and lefs time than is neceffary for infpecting a table of proportional parts, and not the tenth part of that neceffary for interpolating by fecond differences. Yet it is exact enough (if of the fize of a duodecimo page) for interpolating three decimal places. This is ten times more exact than the prefent cafe requires. To return from this digreffion.

Having thus found s in the table, we get x or y by the equations $\frac{as}{w+s}=x$, and $a\frac{ms}{w+ms}=y$.

But here a material circumftance occurs. The weight of alcohol s, and its per centage x, was rightly determined by the fpecific gravity, becaufe it was interpolated between two values, which were experimentally connected with this fpecific gravity. But in making the tranfition from x to y, we only give the per centage in gallons before mixture, but not the number of gallons of alcohol contained in an hundred gallons of mixed liquor. For when we have taken $\overline{a-y}$ and y inftead of w and s, they will indeed make a fimilar compound when mixed, becaufe the proportion of their ingredients is the fame. But they will not make 100 gallons of this compound, becaufe there is a fhrinking or condenfation by mixture, and the fpecific gravity by which we interpolated s is the phyfical or real fpecific gravity correfponding to w and s; while $\frac{w+s}{w\times ms}$, the fpecific gravity implied in the value of y, is the mathematical denfity independent on this condenfation. Since therefore y, together with $\overline{a-y}$, make lefs than 100 gallons of the compound, there muft in 100 gallons of it be more alcohol than is expreffed by y.

Let G be the mathematical fpecific gravity $\left(=\frac{w+s}{w+ms}\right)$, and g the phyfical or real obferved fpecific gravity (which we cannot exprefs algebraically); and let z be the gallons of alcohol really contained in 100 gallons of the compound. The bulk being inverfely as the denfity or fpecific gravity, it is evident that the bulk of the compound muft be to 100 gallons as g to to G. And ſince we want to make it ſtill up to 100 gallons, we muſt increaſe it in the proportion of G to g. And becauſe this augmentation muſt be of the ſame ſtrength with this contracted liquor, both ingredients muſt be increaſed in the proportion of G to g, and we muſt have $G : g = y : z$, and $z = g \times \frac{y}{G}$. Now, inſtead of y, write $a \frac{m s}{w + m s}$, and inſtead of $\frac{1}{G}$ write $\frac{w + m s}{w + s}$, which are reſpectively equal to them. This gives us $z = g a \times \frac{w + m s}{w + s} \times \frac{m s}{w + s}, = g a \times \frac{m s}{w + s}$.

All this will be illuſtrated by an example.

Suppoſe that we have obſerved the ſpecific gravity of a ſpirituous liquor of the temperature 60° to be 0.94128. Looking into Sir Charles Blagden's table, we find the gravities 0.94018 and 0.94296, and the s correſponding to them is 80 and 75, the water in each mixture being 100. By interpolation we obtain the s correſponding to 0.94128, viz. 78. At this temperature $m = \frac{1}{0.825}, = 1.21212$, and $m s = 94.54545$. Therefore $z = 0.94128 \times 100 \times \frac{94.54545}{194.54545}, = 49{,}997$, or very nearly 50.

We have ſeen even perſons not unacquainted with ſubjects of this kind puzzled by this ſort of paradox. z is ſaid to be the per centage of ſpirit in the compound. The compound has the ſame proportion of ingredients when made up to 100 gallons as before, when y was ſaid to be its per centage, and yet y and z are not the ſame. The fact is, that although z is the number of gallons of alcohol really contained in 100 gallons of the compound, and this alcohol is in the ſame proportion as before to the water, this proportion is not that of 50 to 50: for if the ingredients were ſeparated again, there would be 50 gallons of alcohol and 52,876 of water.

The proportion of the ingredients in their ſeparate ſtate is had by the 3d equation $y = a \frac{m s}{w + m s}$, which is equivalent to $G\,a \frac{m s}{w + s}$. For the preſent example y will be found 48.599, and $a - y$, or the water per cent. 51.401, making 100 gallons of unmixed ingredients. We ſee then that there has been added 1.398 gallons of alcohol; and ſince both ingredients are augmented in the proportion of G to g, there have alſo been added 1.478 of water, and the whole addition for making up the 100 gallons of compound is 2.876 gallons; and if the ingredients of the compound were ſeparate, they would amount to 102,876 gallons. This might have been found at the firſt, by the proportion, $G : g - G = 100$: *(The addition)*.

The next queſtion which uſually occurs in buſineſs is to find what denſity will reſult from any propoſed mixture per gallon. This queſtion is ſolved by means of the equation $\frac{w y}{m (a - y)} = s$. In this examination it will be moſt convenient to make $w = a$. If the value of s found in this manner falls on a value in the tables, we have the ſpecific gravity by inſpection. If not, we muſt interpolate.

N. B. The value of m, which is employed in theſe reductions, varies with the temperature. It is always obtained by dividing the ſpecific gravity of alcohol of that temperature by the ſpecific gravity of water of the ſame temperature. The quotient is the real ſpecific gravity of alcohol for that temperature. Both of theſe are to be had in the firſt and laſt copartments of Sir Charles Blagden's table.

Theſe operations for particular caſes give the anſwers to particular occaſional queſtions. By applying them to all the numbers in the table, tables may be conſtructed for ſolving every queſtion by inſpection.

There is another queſtion which occurs moſt frequently in the exciſe tranſactions, and alſo in all compoſitions of ſpirituous liquors, viz. What ſtrength will reſult from a mixture of two compounds of known ſtrength, or mixing any compound with water? To ſolve queſtions of this kind by the table ſo often quoted, we muſt add into one ſum the water per gallon of the different liquors. In like manner, take the ſum of the ſpirits, and ſay, as the ſum of the waters is to that of the alcohols, ſo is a to s; and operate with a and s as before.

Analogous to this is the queſtion of the duties. Theſe are levied on proof ſpirit; that is, a certain duty is charged on a gallon of proof ſpirit; and the gauger's buſineſs is to diſcover how many gallons of proof ſpirit there is in any compound. The ſpecification of proof ſpirit in our exciſe laws is exceedingly obſcure and complex. A gallon weighing 7 pounds 13 ounces (at 55°) is accounted 1 to 6 under proof. The gallon of water contains 58476 grains, and this ſpirit is 54688. Its denſity therefore is 0.93523 at 55°, or (as may be inferred from the table) 0.9335 at 60°. This denſity correſponds to a mixture of 100 grains of water with 93.457 of alcohol. If this be ſuppoſed to reſult from the mixture of 6 gallons of alcohol with 1 of water (as is ſuppoſed by the deſignation of 1 to 6 under proof), the gallon of proof ſpirits conſiſts of 100 parts of ſpirits by weight, mixed with 75 parts of water. Such a ſpirit will have the denſity 0.9162 nearly.

This being premiſed, in order to find the gallons of proof ſpirits in any mixture, find the quantity of alcohol by weight, and then ſay, as 100 to 175, ſo is the alcohol in the compound to the proof ſpirit that may be made of it, and for which the duties muſt be paid.

We have conſidered this ſubject at ſome length, becauſe it is of great importance in the ſpirit-trade to have theſe circumſtances aſcertained with preciſion; and becauſe the ſpecific gravity is the only ſure criterion that can be had of the ſtrength. Firing of gunpowder, or producing a certain bubble by ſhaking, are very vague teſts; whereas, by the ſpecific gravity, we can very ſecurely aſcertain the ſtrength within one part in 500, as will preſently appear.

Sir Charles Blagden, or Mr Gilpin, has publiſhed * a moſt copious ſet of tables, calculated from theſe valuable experiments. In theſe, computations are made for every unit of the hundred, and for every degree of the thermometer. But theſe tables are ſtill not in the moſt commodious form for buſineſs. Mr John Wilſon, an ingenious gentleman reſiding at Dundee, has juſt publiſhed

* Philoſ. Tranſact. 1794.

lished at Edinburgh tables somewhat similar, founded on the same experiments. Both of these tables show the quantities by measure corresponding to every unit by weight of Sir Charles Blagden's experiments, and for every degree of temperature. They also show the per centage of alcohol, and the condensation or the quantity lost by mixture. But as they both retain the original series of parts by weight, which is very unusual, the spirit traders will find considerable difficulty in making use of them. Retaining this series also causes all the per centage numbers (which are the only interesting ones to the trader) to be fractional, and no answer can be had without a double interpolation.

We have therefore calculated a table in the form in which it must be most useful and acceptable to those who are engaged in the spirit trade, showing at once the specific gravity which results from any proportion of admixture in hundredth parts of the whole. This answers immediately the chief questions in the terms in which they are usually conceived and proposed. The two first or leading columns show the proportion in gallons, pints, or other cubic measures, of the mixture, the whole quantity being always 100. The second column shows the corresponding specific gravity: so that we can either find the proportion of the ingredients by the observed specific gravity, or find the gravity resulting from any proportion of the ingredients. A third column shows how much the hundred measures of the two ingredients fall short of making an hundred measures of the compound. A simple proportion, which can be done without the pen, will determine what part of this deficiency must be made up by spirit. The use of this table must now be so familiar to the reader's mind, that we need not give further instructions about it.

This is followed by another similar table, giving an immediate answer to the most usual question, "How many measures of alcohol are there really contained in 100 measures? This is also accompanied by a column of condensation. It would have been somewhat more elegant, had the specific gravities in this table made the equable series and leading column. But we did not advert to this till we had computed the table, and the labour was too great to be repeated for slight reasons. The tables are only for the temperature 60°. To this the spirituous liquors can always be brought in these climates; and in cases where we cannot, a moment's inspection of Sir Charles Blagden's table will point out very nearly (or exactly, by a short computation) the necessary corrections.

Compound.		Specific Gravity.	Cond. per cent.	Compound.		Specific Gravity.	Cond. per cent.	Compound.		Specific Gravity.	Cond. per cent.
S.	W.			S.	W.			S.	W.		
100	0	0.8250		66	34	0.9073	2.5	33	67	0.9640	2.3
99	1	0.8278	0.19	65	35	0.9095	2.6	32	68	0.9651	2.3
98	2	0.8306	0.33	64	36	0.9116	2.6	31	69	0.9662	2.2
97	3	0.8333	0.4	63	37	0.9137	2.6	30	70	0.9673	2.1
96	4	0.8360	0.5	62	38	0.9157	2.6	29	71	0.9683	2.
95	5	0.8387	0.6	61	39	0.9177	2.7	28	72	0.9693	1.9
94	6	0.8413	0.7	60	40	0.9198	2.7	27	73	0.9704	1.9
93	7	0.8439	0.8	59	41	0.9218	2.7	26	74	0.9713	1.8
92	8	0.8465	1.9	58	42	0.9238	2.7	25	75	0.9724	1.7
91	9	0.8491	1.	57	43	0.9257	2.7	24	76	0.9734	1.6
90	10	0.8516	1.1	56	44	0.9277	2.8	23	77	0.9744	1.6
89	11	0.8542	1.2	55	45	0.9296	2.8	22	78	0.9754	1.5
88	12	0.8567	1.3	54	46	0.9316	2.8	21	79	0.9763	1.4
87	13	0.8592	1.4	53	47	0.9335	2.8	20	80	0.9773	1.3
86	14	0.8617	1.5	52	48	0.9353	2.8	19	81	0.9783	1.2
85	15	0.8641	1.5	51	49	0.9371	2.8	18	82	0.9793	1.2
84	16	0.8666	1.6	50	50	0.9388	2.8	17	83	0.9802	1.1
83	17	0.8690	1.7	49	51	0.9406	2.8	16	84	0.9812	1.
82	18	0.8713	1.7	48	52	0.9423	2.8	15	85	0.9822	0.9
81	19	0.8737	1.7	47	53	0.9440	2.8	14	86	0.9832	0.9
80	20	0.8760	1.8	46	54	0.9456	2.7	13	87	0.9842	0.8
79	21	0.8764	1.9	45	55	0.9473	2.7	12	88	0.9853	0.7
78	22	0.8807	2.	44	56	0.9489	2.7	11	89	0.9863	0.7
77	23	0.8830	2.	43	57	0.9505	2.7	10	90	0.9874	0.6
76	24	0.8853	2.1	42	58	0.9520	2.7	9	91	0.9886	0.5
75	25	0.8876	2.1	41	59	0.9535	2.6	8	92	0.9897	0.4
74	26	0.8899	2.2	40	60	0.9549	2.6	7	93	0.9909	0.3
73	27	0.8921	2.2	39	61	0.9563	2.6	6	94	0.9921	0.3
72	28	0.8944	2.3	38	62	0.9577	2.5	5	95	0.9933	0.2
71	29	0.8966	2.3	37	63	0.9590	2.5	4	96	0.9946	0.1
70	30	0.8988	2.4	36	64	0.9603	2.4	3	97	0.9959	0.07
69	31	0.9010	2.5	35	65	0.9616	2.4	2	98	0.9972	0.03
68	32	0.9031	2.5	34	66	0.9628	2.3	1	90	0.9985	0.01
67	33	0.9053	2.5	33	67	0.9640	2.3	0	100	1.0000	0.00
66	34	0.9073	2.5								

Spirituous Liquors.

Spir. per cent.	Specific Gravity.	Contr.	Spir. per cent.	Specific Gravity.	Contr.	Spir. per cent.	Specific Gravity.	Contr.
100	0.82500		66	0.91095	2.59	33	0.96481	2.27
99	0.82629	0.18	65	0.91306	2.62	32	0.96587	2.21
98	0.83142	0.34	64	0.91511	2.64	31	0.96691	2.15
97	0.83449	0.46	63	0.91714	2.66	30	0.96793	2.08
96	0.83750	0.57	62	0.91914	2.68	29	0.96894	2.00
95	0.84048	0.68	61	0.92112	2.70	28	0.96992	1.93
94	0.84339	0.8	60	0.92308	2.72	27	0.97089	1.86
93	0.84621	0.9	59	0.92501	2.74	26	0.97185	1.79
92	0.84900	1.01	58	0.92692	2.76	25	0.97280	1.71
91	0.85172	1.11	57	0.92883	2.77	24	0.97374	1.63
90	0.85443	1.21	56	0.93072	2.78	23	0.97468	1.56
89	0.85704	1.31	55	0.93258	2.80	22	0.97561	1.48
88	0.85971	1.39	54	0.93436	2.81	21	0.97654	1.4
87	0.86228	1.47	53	0.93612	2.81	20	0.97747	1.32
86	0.86483	1.54	52	0.93786	2.82	19	0.97841	1.24
85	0.86737	1.61	51	0.93958	2.81	18	0.97936	1.17
84	0.86987	1.67	50	0.94128	2.79	17	0.98032	1.08
83	0.87235	1.74	49	0.94293	2.78	16	0.98129	1.00
82	0.87481	1.81	48	0.94455	2.76	15	0.98228	.93
81	0.87726	1.88	47	0.94610	2.73	14	0.98328	.85
80	0.87969	1.94	46	0.94768	2.71	13	0.98430	.78
79	0.88207	2.	45	0.94923	2.70	12	0.98634	.71
78	0.88445	2.05	44	0.95074	2.68	11	0.98640	.66
77	0.88676	2.11	43	0.95219	2.66	10	0.98748	.61
76	0.88909	2.17	42	0.95364	2.63	9	0.98858	.51
75	0.89140	2.22	41	0.95502	2.60	8	0.98973	.43
74	0.89367	2.26	40	0.95636	2.58	7	0.99091	.34
73	0.89593	2.31	39	0.95766	2.54	6	0.99211	.25
72	0.89815	2.36	38	0.95894	2.49	5	0.99334	.18
71	0.90035	2.41	37	0.96019	2.46	4	0.99461	.12
70	0.90241	2.49	36	0.96141	2.43	3	0.99591	.7
69	0.90464	2.47	35	0.96258	2.38	2	0.99725	.3
68	0.90675	2.51	34	0.96371	2.33	1	0.99861	.1
67	0.90885	2.55	33	0.96481	2.27	0	1.00000	.0
66	0.91095	2.59						

"In the first table, of which the sole intention is to point out the proportion of ingredients, the specific gravities are computed only to four places, which will always give the answer true to $\frac{1}{8000}$th part. In the last, which is more immediately interesting to the merchant in his transactions with the excise office, the computation is carried one place further."

The consideration of the first of these two tables will furnish some useful information to the reader who is interested in the philosophy of chemical mixture, and who endeavours to investigate the nature of those forces which connect the particles of tangible matter. These vary with the distance of the particle; and therefore the law of their action, like that of universal gravitation, is to be discovered by measuring their sensible effects at their various distances. Their change of distance is seen in the change of density or specific gravity.

Did the individual densities of the water and spirit remain unchanged by mixture, the specific gravity would change by equal differences in the series of mixtures on which this table is constructed; for the bulk being always the same, the change of specific gravity must be the difference between the weight of the gallon of water which is added and that of the gallon of spirit which is taken out. The whole difference of the specific gravities of spirits and water being 1.750 parts in 10,000, the augmentation by each successive change of a measure of spirit for a measure of water would be the 100th part of this, or 17.5. But, by taking the successive differences of density as they occur in the table, we see that they are vastly greater in the first additions of water, being then about 10; after which they gradually diminish to the medium quantity $17\frac{1}{2}$, when water and spirits are mixed in nearly equal bulks. The differences of specific gravity still diminish, and are reduced to 9, when about 75 parts of water are mixed with 25 of spirit. The differences now increase again; and the last, when 99 parts of water are mixed with one part of spirit, the difference from the specific gravity of pure water is above 14.

The mechanical effect, therefore, of the addition of a measure of water to a great quantity of spirit is greater than the similar effect of the addition of a measure of spirits to a great quantity of water. What we call mechanical effect is the local motion, the change of distance of the particles, that the corpuscular forces may again be in equilibrio. Observe, too, that this change is greater than in the proportion of the distance of the particles;

particles; for the denſity of water is to that of ſpirits nearly as 6 to 5, and the changes of ſpecific gravity are nearly as 6 to 3.

We alſo ſee that the changing cauſe, which produces the abſolute condenſation of each ingredient, ceaſes to operate when 75 parts of water have been mixed with 25 of alcohol: for the variation of ſpecific gravity, from diminiſhing comes now to increaſe; and therefore, in this particular ſtate of compoſition, is equable. Things are now in the ſame ſtate as if we were mixing two fluids which did not act on each other, but were mutually diſſeminated, and whoſe ſpecific gravities are nearly as 9 to 10; for the variation 9 of ſpecific gravity may be conſidered as the 100th part of the whole difference, in the ſame manner as 17.7 would have been had water and alcohol ſuſtained no contraction.

The imagination is greatly aſſiſted in the contemplation of geometrical quantity by exhibiting it in its own form. Specific gravity, being an expreſſion of denſity (a notion purely geometrical), admits of this illuſtration.

Plate cccxcix. Fig. 2.

Therefore let AB (fig. 2.) repreſent the bulk of any mixture of water and alcohol. The ſpecific gravity of water may be repreſented by a line of ſuch a length, that AB ſhall be the difference between the gravities of alcohol and water. Suppoſe it extended upwards, towards a, till B a is to A a as 10,000 to 8250. It will ſuit our purpoſe better to repreſent it by a parallelogram a BF e, of any breadth BF. In this caſe the difference of the ſpecific gravities of alcohol and water will be expreſſed by the parallelogram ABFE. If there were no change produced in the denſity of one or both ingredients, the ſpecific gravity of the compound would increaſe as this parallelogram does, and AGHE would be the augmentation correſponding to the mixture of the quantity AG of alcohol with the quantity GB of water, and ſo of other mixtures. But, to expreſs the augmentation of denſity as it really obtains, we muſt do it by ſome curvilineal area DABCHD, which varies at the rate determined by Sir Charles Blagden's experiments. This area muſt be preciſely equal to the rectangle ABFE. It muſt therefore fall without it in ſome places, and be deficient in others. Let DMHKC be the curve which correſponds with theſe experiments. It is evident to the mathematical reader, that the ordinates LM, GH, IK, &c. of this curve are in the ultimate ratio of the differences of the obſerved ſpecific gravities. If A α, $\omega\beta$, &c. are each = 5, the little ſpaces A $\omega\delta$ D, $\omega\beta b\delta$, &c. will be preciſely equal to the differences of the ſpecific gravities 0.8250; 0.8387; 0.8516; &c. correſponding to the different mixtures of water and alcohol. The curve cuts the ſide of the parallelogram in K, where the ordinate GK expreſſes the mean variation of denſity 0.0017.5. IK is the ſmalleſt variation. The condenſation may be expreſſed by drawing a curve $dm\,G\,fk$ parallel to DMGKF, making Dd=AE. The condenſation is now repreſented by the ſpaces comprehended between this laſt curve and the abſciſſa AGB, reckoning thoſe negative which lie on the other ſide of it. This ſhows, not only that the condenſation is greateſt in the mixture AG × GB, but alſo that in mixing ſuch a compound with another AI × IB, there is a rarefaction. Another curve ANOPB may be drawn, of which the ordinates LN, GP, IO, &c. are proportional to the areas ALmd, AGmD, AIkGmd (=AGmd—GIk), &c. This curve ſhows the whole condenſation.

This manner of repreſenting the ſpecific gravities of mixtures will ſuggeſt many curious inferences to ſuch as will conſider them in the manner of Boſcovich, with a view to aſcertain the nature of the forces of coheſion and chemical affinities: And this manner of viewing the ſubject becomes every day more promiſing, in conſequence of our improvements in chemical knowledge; for we now ſee, that mechaniſm, or motive forces, are the cauſes of chemical action. We ſee in almoſt every caſe, that chemical affinities are comparable with mechanical preſſures; becauſe the converſion of a liquid into a vapour or gas is prevented by atmoſpheric preſſure, and produced by the great chemical agent heat. The action of heat, therefore, or of the cauſe of heat, is a mechanical action, and the forces are common mechanical forces, with which we are familiarly acquainted.

" It may be alſo remarked in the column of contractions, that in the beginning the contractions augment nearly in the proportion of the quantity of ſpirits (but more ſlowly); whereas, in the end, the contractions are nearly in the duplicate proportion of the quantity of water. This circumſtance deſerves the conſideration of the philoſopher. We have repreſented it to the eye by the curve $\alpha\,g\,h\,d$."

We ſhould here take ſome notice of the attempt made to elude ſome part of the duties, by adding ſome ingredient to the ſpirits. But our information on this ſubject is not very exact; and beſides it would be doing no ſervice to the trader to put fraud more in his power. There are ſome ſalts which make a very great augmentation of denſity, but they render the liquor unpalatable. Sugar is frequently uſed with this view; 16 grains of refined ſugar diſſolved in 1000 grains of proof ſpirits gave it no ſuſpicious taſte, and increaſed its ſpecific gravity from 0.920 to 0.925, which is a very great change, equivalent to the addition of 9 grains of water to a mixture of 100 grains of alcohol and 80 of water.

SPIRLING, a ſpecies of fiſh. See SALMO, ICHTHYOLOGY, p. 99.

SPITHEAD, a road between Portſmouth and the iſle of Wight, where the royal navy of Great Britain frequently rendezvous.

SPITTLE, in *Phyſiology*. See SALIVA.

SPITZBERGEN. See GREENLAND, N° 10.

SPLACHNUM, a genus of plants belonging to the claſs of cryptogamia, and order of muſci. See BOTANY *Index*.

SPLEEN. See ANATOMY *Index*.

SPLEEN-Wort. See ASPLENIUM, BOTANY *Index*.

SPLENETIC, a perſon afflicted with an obſtruction of the ſpleen.

SPLENT, or SPLINT, among farriers, a callous inſenſible excreſcence, breeding on the ſhank-bone of horſes. See FARRIERY.

SPLICING, in the ſea-language, is the untwiſting the ends of two cables or ropes, and working the ſeveral ſtrands into one another by a fidd, ſo that they become as ſtrong as if they were but one rope.

SPOILS, whatever is taken from the enemy in time of war. Among the ancient Greeks, the ſpoils were divided among the whole army; only the general's ſhare was

was largest: but among the Romans, the spoils belonged to the republic.

SPOLETTO, a duchy of Italy, bounded on the north by the marquisate of Ancona and duchy of Urbino, on the east by Farther Abruzzo, on the south by Sabina and the patrimony of St Peter, and on the west by Orvieto and Perugino. It is about 55 miles in length and 40 in breadth. It was anciently a part of Umbria, and now belongs to the pope.—The name of the capital city is also *Spoletto*. It was formerly a large place, but in 1703 was ruined by an earthquake; from whence it has never recovered itself.

SPOLIATION, in ecclesiastical law, is an injury done by one clerk or incumbent to another, in taking the fruits of his benefice without any right thereunto, but under a pretended title. It is remedied by a decree to account for the profits so taken. This injury, when the *jus patronatus*, or right of advowson, doth not come in debate, is cognizable in the spiritual court: as if a patron first presents A to a benefice, who is instituted and inducted thereto; and then, upon pretence of a vacancy, the same patron presents B to the same living, and he also obtains institution and induction. Now if A disputes the fact of the vacancy, then that clerk who is kept out of the profits of the living, whichever it be, may sue the other in the spiritual court for the spoliation, or taking the profits of his benefice. And it shall there be tried, whether the living were or were not vacant; upon which the validity of the second clerk's pretensions must depend. But if the right of patronage comes at all into dispute, as if one patron presented A, and another patron presented B, there the ecclesiastical court hath no cognizance, provided the tithes sued for amount to a fourth part of the value of the living, but may be prohibited at the instance of the patron by the king's writ of *indicavit*. So also if a clerk, without any colour of title, ejects another from his parsonage, this injury must be redressed in the temporal courts: for it depends upon no question determinable by the spiritual law (as plurality of benefices or no plurality, vacancy or no vacancy), but is merely a civil injury.

SPONDEE, in ancient poetry, a foot consisting of two long syllables, as *omnes*.

SPONDIAS, Brasilian or Jamaica Plum, a genus of plants belonging to the class of decandria. See Botany *Index*.

SPONGIA, Sponge; a genus of animals belonging to the class of vermes, and order of zoophyta. It is fixed, flexible, and very torpid, growing in a variety of forms, composed either of reticulated fibres, or masses of small spines interwoven together, and clothed with a living gelatinous flesh, full of small mouths or holes on its surface, by which it sucks in and throws out the water. Fifty species have already been discovered, of which 10 belong to the British coasts. See Helminthology *Index*.

So early as the days of Aristotle sponges were supposed to possess animal life; the persons employed in collecting them having observed them shrink when torn from the rocks, thus exhibiting symptoms of sensation. The same opinion prevailed in the time of Pliny: But no attention was paid to this subject till Count Marsigli examined them, and declared them vegetables. Dr Peysonell, in a paper which he sent to the Royal Society in the year 1752, and in a second in 1757, affirmed they were not vegetables, but the production of animals; and has accordingly described the animals, and the process which they performed in making the sponges. Mr Ellis, in the year 1762, was at great pains to discover these animals. For this purpose he dissected the spongia urens, and was surprised to find a great number of small worms of the genus of nereis or sea scolopendra, which had pierced their way through the soft substance of the sponge in quest of a safe retreat. That this was really the case, he was fully assured of, by inspecting a number of specimens of the same sort of sponge, just fresh from the sea. He put them into a glass filled with sea-water; and then, instead of seeing any of the little animals which Dr Peysonell described, he observed the papillæ or small holes with which the papillæ are surrounded contract and dilate themselves. He examined another variety of the same species of sponge, and plainly perceived the small tubes inspire and expire the water. He therefore concluded, that the sponge is an animal, and that the ends or openings of the branched tubes are the mouths by which it receives its nourishment, and discharges its excrements.

SPONSORS, among Christians, are those persons who, in the office of baptism, answer or are sureties for the persons baptized.

SPONTANEOUS, a term applied to such motions of the body and operations of the mind as we perform of ourselves without any constraint.

SPOON-bill. See Platalea, Ornithology *Index*.

SPOONING, in the sea-language, is said of a ship, which being under sail in a storm at sea, is unable to bear it, and consequently forced to go right before the wind.

SPORADES, among ancient astronomers, a name given to such stars as were not included in any constellation.

SPORADIC diseases, among physicians, are such as seize particular persons at any time or season, and in any place; in which sense they are distinguished from epidemical and endemical diseases.

SPOTS, in *Astronomy*, certain places of the sun's or moon's disk, observed to be either more bright or dark than the rest; and accordingly called *faculæ et maculæ*. See Astronomy *Index*.

SPOTSWOOD, John, archbishop of St Andrew's in Scotland, was descended from the lairds of Spotswood in the Merse, and was born in the year 1565. He was educated in the university of Glasgow, and succeeded his father in the parsonage of Calder when but 18 years of age. In 1601 he attended Lodowick duke of Lennox as his chaplain, in an embassy to the court of France for confirming the ancient amity between the two nations, and returned in the ambassador's retinue through England. When he entered into the archbishopric of Glasgow, he found there was not 100l. sterling of yearly revenue left; yet such was his care for his successors, that he greatly improved it, and much to the satisfaction of his diocese. After having filled this see 11 years, he was raised to that of St Andrew's in 1615, and made primate and metropolitan of all Scotland. He presided in several assemblies for restoring the ancient discipline, and bringing the church of Scotland to some degree of uniformity with that of England. He continued in high esteem with King James I. nor was he less valued by King

King Charles I. who was crowned by him in 1633, in the abbey-church of Holyroodhoufe. In 1635, upon the death of the earl of Kinnoul chancellor of Scotland, our primate was advanced to that poft; but had fcarcely held it four years, when the confufions beginning in Scotland, he was obliged to retire into England; and being broken with age, grief, and ficknefs, died at London in 1639, and was interred in Weftminfter-abbey. He wrote A Hiftory of the Church of Scotland from the year 203 to the reign of King James VI. in folio.

SPOUT, or *Water-Spout*. See *Water-Spout*.

Spout-Fifh. See Solen, Conchology *Index*.

SPRAT, Dr Thomas, bifhop of Rochefter, was born in 1636. He had his education at Oxford, and after the Reftoration entered into holy orders. He became fellow of the Royal Society, chaplain to George duke of Buckingham, and chaplain in ordinary to King Charles II. In 1667 he publifhed the Hiftory of the Royal Society, and a Life of Mr Cowley; who, by his laft will, left to his care his printed works and MSS. which were accordingly publifhed by him. In 1668 he was inftalled prebendary of Weftminfter; in 1680, was appointed canon of Windfor; in 1683, dean of Weftminfter; and in 1684, confecrated to the bifhopric of Rochefter. He was clerk of the clofet to King Jas. II.; in 1685, was made dean of the chapel royal; and the year following, was appointed one of the commiffioners for ecclefiaftical affairs. In 1692 his lordfhip, with feveral other perfons, was charged with treafon by two men, who drew up an affociation, in which they whofe names were fubfcribed declared their refolution to reftore King James; to feize the princefs of Orange, dead or alive; and to be ready with 30,000 men to meet King James when he fhould land. To this they put the names of Sancroft, Sprat, Marlborough, Salifbury, and others. The bifhop was arrefted, and kept at a meffenger's, under a ftrict guard, for eleven days. His houfe was fearched, and his papers feized, among which nothing was found of treafonable appearance, except one memorandum, in the following words: *Thorough-paced doctrine*. Being afked at his examination the meaning of the words, he faid that, about 20 years before, curiofity had led him to hear Daniel Burgefs preach; and that being ftruck with his account of a certain kind of doctrine, which he faid *entered at one ear, and pacing through the head went out at the other*, he had inferted the memorandum in his table-book, that he might not lofe the fubftance of fo ftrange a fermon. His innocence being proved, he was fet at liberty, when he publifhed an account of his examination and deliverance; which made fuch an impreffion upon him, that he commemorated it through life by an yearly day of thankfgiving. He lived to the 79th year of his age, and died May 20. 1713. His works, befides a few poems of little value, are. "The Hiftory of the Royal Society;" "The Life of Cowley;" "The Anfwer to Sorbiere;" "The Hiftory of the Rye-houfe Plot;" "The Relation of his own Examination;" and a volume of "Sermons." Dr Johnfon fays, "I have heard it obferved with great juftnefs, that every book is of a different kind, and that each has its diftinct and characteriftical excellence."

Sprat. See Clupea, Ichthyology *Index*.

SPRAY, the fprinkling of the fea, which is driven from the top of a wave in ftormy weather. It differs from fpoon-drift, as being only blown occafionally from the broken furface of a high wave; whereas the latter continues to fly horizontally along the fea, without intermiffion, during the excefs of a tempeft or hurricane.

SPRING, in *Natural Hiftory*, a fountain or fource of water rifing out of the ground.

Many have been the conjectures of philofophers concerning the origin of fountains, and great pains have been taken both by the members of the Royal Society and thofe of the Academy of Sciences at Paris, in order to afcertain the true caufe of it. It was Ariftotle's opinion, and held by moft of the ancient philofophers after him, that the air contained in the caverns of the earth, being condenfed by cold near its furface, was thereby changed into water; and that it made its way through, where it could find a paffage. But we have no experience of any fuch tranfmutation of air into water.

Thofe who imagine that fountains owe their origin to waters brought from the fea by fubterraneous ducts, give a tolerable account how they lofe their faltnefs by percolation as they pafs through the earth: but they find great difficulty in explaining by what power the water rifes above the level of the fea to near the tops of mountains, where fprings generally abound; it being contrary to the laws of hydroftatics, that a fluid fhould rife in a tube above the level of its fource. However, they have found two ways whereby they endeavour to extricate themfelves from this difficulty. The one is that of Des Cartes, who imagines, that after the water is become frefh by percolation, it is raifed out of the caverns of the earth in vapour towards its furface; where meeting with rocks near the tops of mountains in the form of arches or vaults, it fticks to them, and runs down their fides, (like water in an alembic), till it meets with proper receptacles, from which it fupplies the fountains. Now this is a mere hypothefis, without foundation or probability: for, in the firft place, we know of no internal heat of the earth to caufe fuch evaporation; or if that were allowed, yet it is quite incredible that there fhould be any caverns fo fmooth and void of protuberances as to anfwer the ends of an alembic, in collecting and condenfing the vapours together in every place where fountains arife. There are others (as Varenius, &c.) who fuppofe that the water may rife through the pores of the earth, as through capillary tubes by attraction. But hereby they fhow, that they are quite unacquainted with what relates to the motion of a fluid through fuch tubes: for when a capillary tube opens into a cavity at its upper end, or grows larger and larger, fo as to ceafe to be capillary at that end, the water will not afcend through that tube into the cavity, or beyond where the tube is capillary; becaufe that part of the periphery of the cavity, which is partly above the furface of the water and partly below it, is not of the capillary kind. Nay, if the cavity is continually fupplied with water, it will be attracted into the capillary tube, and run down it as through a funnel, if the lower end is immerged in the fame fluid, as in this cafe it is fuppofed to be.

It has been a generally received opinion, and much efpoufed by Mariotte (a diligent obferver of nature), that the rife of fprings is owing to the rains and melted fnow. According to him, the rain-water which falls upon the hills and mountains, penetrating the furface, meets

Spring. meets with clay or rocks contiguous to each other; along which it runs, without being able to penetrate them, till, being got to the bottom of the mountain, or to a confiderable diftance from the top, it breaks out of the ground, and forms fprings.

In order to examine this opinion, Mr Perrault, De la Hire, and D. Sideleau, endeavoured to make an eftimate of the quantity of rain and fnow that falls in the fpace of a year, to fee whether it would be fufficient to afford a quantity of water equal to that which is annually difcharged into the fea by the rivers. The refult of their inquiries was, that the quantity of rain and fnow which fell in a year into a cylindrical veffel would fill it (if fecured from evaporating) to the height of about nineteen inches. Which quantity D. Sideleau fhowed, was not fufficient to fupply the rivers; for that thofe of England, Ireland, and Spain, difcharge a greater quantity of water annually, than the rain, according to that experiment, is able to fupply. Befides which, another obfervation was made by them at the fame time, viz. that the quantity of water raifed in vapour, one year with another, amounted to about thirty-two inches, which is thirteen more than falls in rain: a plain indication that the water of fountains is not fupplied by rain and melted fnow.

Thus the true caufe of the origin of fountains remained undifcovered, till Dr Halley, in making his celeftial obfervations upon the tops of the mountains at St Helena, about 800 yards above the level of the fea, found, that the quantity of vapour which fell there (even when the fky was clear) was fo great, that it very much impeded his obfervations, by covering his glaffes with water every half quarter of an hour; and upon that he attempted to determine by experiment the quantity of vapour exhaled from the furface of the fea, as far as it rifes from heat, in order to try whether that might be a fufficient fupply for the water continually difcharged by fountains. The procefs of his experiment was as follows: He took a veffel of water falted to the fame degree with that of fea water, in which he placed a thermometer; and by means of a pan of coals brought the water to the fame degree of heat, which is obferved to be that of the air in our hotteft fummer; this done, he fixed the veffel of water with the thermometer in it to one end of a pair of fcales, and exactly counterpoifed it with weights on the other: then, at the end of two hours, he found, by the alteration made in the weight of the veffel, that about a fixtieth part of an inch of the depth of the water was gone off in vapour; and therefore, in twelve hours, one tenth of an inch would have gone off. Now this accurate obferver allows the Mediterranean fea to be forty degrees long; and four broad, (the broader parts compenfating for the narrower, fo that its whole furface is 160 fquare degrees); which, according to the experiment, muft yield at leaft 5,280,000,000 tons of water: In which account no regard is had to the wind and the agitation of the furface of the fea, both which undoubtedly promote the evaporation.

It remained now to compare this quantity of water with that which is daily conveyed into the fame fea by the rivers. The only way to do which was to compare them with fome known river; and accordingly he takes his computation from the river Thames; and, to avoid all objections, makes allowances, probably greater than what were abfolutely neceffary. Spring

The Mediterranean receives the following confiderable rivers, viz. the Iberus, the Rhone, the Tyber, the Po, the Danube, the Niefter, the Boryfthenes, the Tanais, and the Nile. Each of thefe he fuppofes to bring down ten times as much water as the Thames, whereby he allows for fmaller rivers which fall into the fame fea. The Thames, then, he finds by meafuration to difcharge about 20,300,000 tons of water a-day. If therefore the above-faid nine rivers yield ten times as much water as the Thames doth, it will follow, that all of them together yield but 1827 millions of tons in a day, which is but little more than one-third of what is proved to be raifed in vapour out of the Mediterranean in the fame time. We have therefore from hence a fource abundantly fufficient for the fupply of fountains.

Now having found that the vapour exhaled from the fea is a fufficient fupply for the fountains, he proceeds in the next place to confider the manner in which they are raifed; and how they are condenfed into water again, and conveyed to the fources of fprings.

In order to this he confiders, that if an atom of water was expanded into a fhell or bubble, fo as to be ten times as big in diameter as when it was water, that atom would become fpecifically lighter than air; and therefore would rife fo long as the warmth which firft feparated it from the furface of the water fhould continue to diftend it to the fame degree; and confequently, that vapours may be raifed from the furface of the fea in that manner, till they arrive at a certain height in the atmofphere, at which they find air of equal fpecific gravity with themfelves. Here they will float till, being condenfed by cold, they become fpecifically heavier than the air, and fall down in dew; or being driven by the winds againft the fides of mountains (many of which far furpafs the ufual height to which the vapours would of themfelves afcend), are compelled by the ftream of the air to mount up with it to the tops of them; where being condenfed into water, they prefently precipitate, and gleeting down by the crannies of the ftones, part of them enters into the caverns of the hills; which being once filled, all the overplus of water that comes thither runs over by the loweft place, and breaking out by the fides of the hills forms fingle fprings. Many of thefe running down by the valleys between the ridges of the hills, and coming to unite, form little rivulets or brooks: many of thefe again meeting in one common valley, and gaining the plain ground, being grown lefs rapid, become a river; and many of thefe being united in one common channel, make fuch ftreams as the Rhine and the Danube; which latter, he obferves, one would hardly think to be a collection of water condenfed out of vapour, unlefs we confider how vaft a tract of ground that river drains, and that it is the fum of all thofe fprings which break out on the fouth fide of the Carpathian mountains, and on the north fide of the immenfe ridge of the Alps, which is one continued chain of mountains from Switzerland to the Black fea.

Thus one part of the vapours which are blown on the land is returned by the rivers into the fea from whence it came. Another part falls into the fea before it reaches the land; and this is the reafon why the rivers do not return fo much water into the Mediterra-

Spring. nean as is raifed in vapour. A third part falls on the low lands, where it affords nourifhment to plants; yet it does not reft there, but is again exhaled in vapour by the action of the fun, and is either carried by the winds to the fea to fall in rain or dew there, or elfe to the mountains to become the fources of fprings.

However, it is not to be fuppofed that all fountains are owing to one and the fame caufe; but that fome proceed from rain and melted fnow, which, fubfiding through the furface of the earth, makes its way into certain cavities, and thence iffues out in the form of fprings; becaufe the waters of feveral are found to increafe and diminifh in proportion to the rain which falls: that others again, efpecially fuch as are falt, and fpring near the fea-fhore, owe their origin to fea-water percolated through the earth; and fome to both thefe caufes: though without doubt moft of them, and efpecially fuch as fpring near the tops of high mountains, receive their waters from vapours, as before explained.

This reafoning of Dr Halley's is confirmed by more recent obfervations and difcoveries. It is now found, that though water is a tolerable conductor of the electric fluid, dry earth is an electric *per fe*, confequently the dry land muft always be in an electrified ftate compared with the ocean, unlefs in fuch particular cafes as are mentioned under the article EARTHQUAKE, N° 82. It is alfo well known, that fuch bodies as are in an electrified ftate, whether *plus* or *minus*, will attract vapour, or other light fubftances that come near them. Hence the vapours that are raifed from the ocean muft neceffarily have a tendency to approach the land in great quantity, even without the affiftance of the wind, though this laft muft undoubtedly contribute greatly towards the fame purpofe, as Dr Halley juftly obferves. In like manner, the higher grounds are always in a more electrified ftate than the lower ones: and hence the vapours having once left the ocean and approached the fhore, are attracted by the high mountains; of which Mr Pennant gives an inftance in Snowdon. Hence we may fee the reafon why fprings are fo common in the neighbourhood of mountains, they being fo advantageoufly formed in every refpect for collecting and condenfing the vapours into water.

The heat of fprings is generally the fame with the mean temperature of the atmofphere. The mean temperature of the fouth of England is 48°; in Scotland, near Edinburgh, it is 45°; in the north of Ireland it is 48°, and on the fouth coaft about 51°. At Upfal, in Sweden, it is 43°, and in Paris 53°. According to accurate experiments made by eminent philofophers, the heat of the fprings in thefe different countries correfponds with the medium temperature. We have not heard that fimilar experiments have been made in other countries, or we fhould have been careful to collect them. We do not, however, doubt but they have been made in moft countries of Europe; yet we fufpect little attention has been paid to this fubject within the tropical regions.

Though this coincidence of the heat of fprings with the mean temperature of the climate where they flow, feems to be a general fact, yet it admits of many exceptions. In many parts of the world there are fprings which not only exceed the mean temperature, but even the ftrongeft meridian heat ever known in the torrid regions. The following table will give a diftinct notion of the degrees of heat which different fprings have been found to poffefs, according to the experiments of philofophers. It is neceffary to remark, that experiments made upon the fame fprings, made by different perfons, vary a little from one another, which may be owing to many accidents eafily accounted for. Where this is the cafe, we fhall mention both the loweft and higheft degree of heat which has been afcribed to the fame fpring, according to Fahrenheit's thermometer.

Places.	Springs.	Higheft degree of heat.	Loweft degree of heat.
Briftol,	St Vincent's or the hot well,	84	76
Buxton,	Gentleman's bath,	82	
Matlock,		69	
Bath,	King's bath,	119	113
Aix-la-Chapelle,		146	136
Barege,		122	
Pifa,		104	
Caroline baths in Bohemia,	Prudel or furious,	165	
Iceland,	Geyzer,	212	

In cold countries, where congelation takes place, the heat of the earth is confiderably above the freezing point, and continues fo through the whole year. From experiments that have been made in mines and deep pits, it appears that this heat is uniform and ftationary at a certain depth. But as the heat of thefe fprings far exceeds the common heat of the internal parts of the earth, it muft be occafioned by caufes peculiar to certain places; but what thefe caufes are it is no eafy matter to determine. We are certain, indeed, that hot fprings receive their heat from fome fubterranean caufe; but it is a matter of difficulty to inveftigate how this heat is produced and preferved. Theories, however, have been formed on this fubject. The fubterranean heat has been afcribed to the electrical fluid, and to a great body of fire in the centre of the earth: But we fufpect that the nature of the electrical fluid and its effects are not fufficiently underftood. As to the fuppofition that the heat of fprings is owing to a central fire, it is too hypothetical to require any refutation. From what then does this heat originate, and whence is the fuel which has produced it for fo many ages? To enable us to anfwer thefe queftions with precifion, more information is neceffary than we have hitherto obtained refpecting the ftructure of the internal parts of the earth. It is peculiarly requifite that we fhould be made acquainted with the foffils which are moft common in thofe places where hot fprings abound. We fhould then perhaps difcover that hot fprings always pafs through bodies of a combuftible nature. It is well known to chemifts, that when water is mixed with the vitriolic acid, a degree of heat is produced fuperior to that of boiling water. It is alfo an eftablifhed fact, that when water meets with pyrites, that is, a mixture of fulphur and iron, a violent inflammation takes place. If, therefore, we could prove that thefe materials exift in the ftrata from which hot fprings are derived, we fhould be enabled to give a fatisfactory account of this curious phenomenon. As fome apology for this fuppofition, we may add, that moft of the hot fprings mentioned above have been found by analyfis to be impregnated with fulphur, and fome of them with iron.

Spring ‖ Spruce-Beer.

iron. It muſt, however, be acknowledged, that the hot ſprings of Iceland, which are 212°, the heat of boiling water, according to an accurate analyſis of their contents by the ingenious Dr Black, were neither found to contain iron nor ſulphur. It will therefore, perhaps, be neceſſary that we ſhould wait with patience, and continue to collect facts, till the ſciences of chemiſtry and mineralogy ſhall be ſo far advanced as to enable us to form a permanent theory on this ſubject.

Gray's Letters from Germany and Switzerland.

Springs are of different kinds. Some are perennial, or continue to flow during the whole year; others flow only during the rainy ſeaſon; ſome ebb and flow. At Torbay there is one of this kind, which ebbs and flows five or ſix inches every hour. There is another near Coriſo in Italy, which ebbed and flowed three times a-day in the time of Pliny, and continues to do ſo ſtill. A ſpring near Henly ſometimes flows for two years together, and then dries up for an equal period. For the ingredients found in ſprings, ſee *MINERAL-Waters*.

SPRING, in *Mechanics*, denotes a thin piece of tempered ſteel, or other elaſtic ſubſtance, which being wound up ſerves to put machines in motion by its elaſticity, or endeavours to unbend itſelf; ſuch is the ſpring of a watch, clock, or the like.

SPRING, *Ver*, in coſmography, denotes one of the ſeaſons of the year; commencing, in the northern parts of the world, on the day the ſun enters the firſt degree of Aries, which is about the 10th day of March, and ending when the ſun leaves Gemini; or, more ſtrictly and generally, the ſpring begins on the day when the diſtance of the ſun's meridian altitude from the zenith, being on the increaſe, is at a medium between the greateſt and leaſt. The end of the ſpring coincides with the beginning of ſummer. See SUMMER.

Elater SPRING, in *Phyſics*, denotes a natural faculty or endeavour of certain bodies, to return to their firſt ſtate, after having been violently put out of it by compreſſing, or bending them. This faculty is, by philoſophers, uſually denominated *elaſtic force*, or *elaſticity*.

SPRING-Tide. See ASTRONOMY *Index*, and TIDE.

Burning SPRINGS. See *BURNING-Springs*.

SPRINGER, or *SPRING-Bok*. See CAPRA, MAMMALIA *Index*.

SPRIT, a ſmall boom or pole which croſſes the ſail of a boat diagonally, from the maſt to the upper hindmoſt corner of the ſail, which it is uſed to extend and elevate; the lower end of the ſprit reſts in a ſort of wreath or collar called the *ſnotter*, which encircles the maſt in that place.

SPRITSAIL. See SAIL and SHIP.

SPRITSAIL-Topſail. See SAIL and SHIP.

SPRUCE-TREE. See PINUS, BOTANY *Index*.

SPRUCE-Beer, a cheap and wholeſome liquor, which is thus made: Take of water 16 gallons, and boil the half of it. Put the water thus boiled, while in full heat, to the reſerved cold part, which ſhould be previouſly put into a barrel or other veſſel; then add 16 pounds of treacle or molaſſes, with a few table ſpoonfuls of the eſſence of ſpruce, ſtirring the whole well together; add half a pint of yeaſt, and keep it in a temperate ſituation, with the bung hole open, for two days, till the fermentation be abated. Then cloſe it up or bottle it off, and it will be fit for being drunk in a few days afterwards. In North America, and perhaps in other countries, where the black and white ſpruce-firs abound, inſtead of adding the *eſſence* of the ſpruce at the ſame time with the molaſſes, they make a decoction of the leaves and ſmall branches of theſe trees, and find the liquor equally good. It is a powerful antiſcorbutic, and may prove very uſeful in long ſea voyages.

Spruce-Beer ‖ Square.

SPUNGE, or SPONGE. See SPONGIA.

SPUNGING, in *Gunnery*, the cleaning of the inſide of a gun with a ſponge, in order to prevent any ſparks of fire from remaining in it, which would endanger the life of him that ſhould load it again.

SPUN-YARN, among ſailors, is a kind of line made from rope yarn, and uſed for ſeizing or faſtening things together.

SPUNK. See BOLETUS, BOTANY *Index*.

SPUR, a piece of metal conſiſting of two branches encompaſſing a horſeman's heel, and a rowel in form of a ſtar, advancing out behind to prick the horſe.

SPUR-Winged Water-Hen. See PARRA, ORNITHOLOGY *Index*.

SPURGE. See EUPHORBIA, } BOTANY *Index*.
SPURGE-Laurel. See DAPHNE, }
SPURREY. See SPERGULA, }

SPY, a perſon hired to watch the actions, motions, &c. of another; particularly what paſſes in a camp. When a ſpy is diſcovered, he is hanged immediately.

SQUADRON, in military affairs, denotes a body of horſe whoſe number of men is not fixed; but is uſually from 100 to 200.

SQUADRON of Ships, either implies a detachment of ſhips employed on any particular expedition, or the third part of a naval armament.

SQUADS, in a military ſenſe, are certain diviſions of a company into ſo many ſquads, generally into three or four. The uſe of forming companies into as many ſquads of inſpection as it has ſerjeants and corporals, is proved by thoſe regiments who have practiſed that method; as by it the irregularity of the ſoldiers is conſiderably reſtrained, their dreſs improved, and the diſcipline of the regiment in general moſt remarkably forwarded. Every officer ſhould have a roll of his company by ſquads.

SQUALL, a ſudden and violent blaſt of wind, uſually occaſioned by the interruption and reverberation of the wind from high mountains. Theſe are very frequent in the Mediterranean, particularly that part of it which is known by the name of the *Levant*, as produced by the repulſion and new direction which the wind meets with in its paſſage between the various iſlands of the Archipelago.

SQUALUS, the SHARK; a genus of fiſhes arranged by Linnæus under the claſs of amphibia, and the order of nantes, but by Gmelin referred to the claſs of fiſhes, and order of chondropteryii. See ICHTHYOLOGY *Index*.

SQUAMARIA. See LATHRÆA, BOTANY *Index*.

SQUAMOUS, in *Anatomy*, a name given to the ſpurious or falſe ſutures of the ſkull, becauſe compoſed of ſquamæ or ſcales like thoſe of fiſhes.

SQUARE, in *Geometry*, a quadrilateral figure both equilateral and equiangular. See GEOMETRY.

SQUARE-Root. See ALGEBRA and ARITHMETIC, N° 32. and 34.

Hollow SQUARE, in the military art, a body of foot drawn

Square, Squaring.

drawn up with an empty ſpace in the middle, for the colours, drums, and baggage, faced and covered by the pikes every way to keep off the horſe.

SQUARE, among *Mechanics*, an inſtrument conſiſting of two rules or branches, faſtened perpendicularly at one end of their extremities, ſo as to form a right angle. It is of great uſe in the deſcription and menſuration of right angles, and laying down perpendiculars.

T SQUARE, or *Tee Square*, an inſtrument uſed in drawing, ſo called from its reſemblance to the capital letter T.

SQUARE-Rigged, an epithet applied to a ſhip whoſe yards are very long. It is alſo uſed in contradiſtinction to all veſſels whoſe ſails are extended by ſtays or lateen-yards, or by booms and gaffs; the uſual ſituation of which is nearly in the plane of the keel; and hence,

SQUARE-Sail, is a ſail extended to a yard which hangs parallel to the horizon, as diſtinguiſhed from the other ſails which are extended by booms and ſtays placed obliquely. This ſail is only uſed in fair winds, or to ſcud under in a tempeſt. In the former caſe, it is furniſhed with a large additional part called the *bonnet*, which is then attached to its bottom, and removed when it is neceſſary to SCUD. See SCUDDING.

SQUARING, or *QUADRATURE of the Circle*, ſignifies the finding a ſquare exactly equal to the area of a given circle. This problem however has not been, and probably cannot be, ſtrictly reſolved by the commonly admitted principles of geometry; mathematicians having hitherto been unable to do more than to find a ſquare that ſhall differ from the area of any propoſed circle by as ſmall a quantity as they pleaſe. The quadrature of the circle is a problem of the ſame degree of difficulty, and indeed may be regarded as identical with another geometrical problem, namely, the *Rectification of the circle*, or the finding a ſtraight line equal to its circumference; for the area of a circle is equal to that of a rectangle contained by the radius and a ſtraight line equal to half the circumference (GEOMETRY, Sect. VI. Prop. 3.): therefore, if a ſtraight line exactly equal to the circumference could be found, a rectilineal ſpace preciſely equal to the area might alſo be found, and the contrary. But although no perfectly accurate reſolution of the problem has been obtained under either form, we can always find approximate values of the area and circumference; and therefore it is now cuſtomary to apply the terms *quadrature* and *rectification* of the circle alſo to theſe.

The problem of the quadrature of the circle appears to have engaged the attention of geometers at a very early period; for we are told that Anaxagoras, who lived about 500 years before Chriſt, attempted its ſolution while confined in priſon on account of his philoſophical opinions. We are ignorant of the reſult of his reſearches; but although we cannot ſuppoſe they were attended with any ſucceſs, we may reaſonably conclude that we are indebted to them for the diſcovery of ſome of the properties of the figure, which are now known as elementary propoſitions in geometry.

Hippocrates of Chios was likewiſe engaged in trying to reſolve the ſame problem, and it was no doubt in the courſe of his inquiries into this ſubject that he diſcovered the quadrature of the curvilineal ſpace, which is now known by the name of the *Lune* of Hippocrates. The nature of this diſcovery may be briefly explained as follows. Let ABCD be a circle (Plate D. fig. 1.), H its centre, AC its diameter, ADC a triangle inſcribed in the ſemicircle, having its ſides AD, DC equal to one another. On D as a centre, with DA or DC as a radius, let the quadrantal arch AEC be deſcribed, then ſhall the curvilineal ſpace bounded by the ſemicircle ABC and the quadrantal arch AEC (which is the *Lune* of Hippocrates) be equal to the rectilineal triangle ADC. For becauſe circles are to one another as the ſquares of the radii (GEOMETRY, Sect. VI. Prop. 4.); the circle having DA for its radius will be to the circle having HA for its radius as the ſquare of DA to the ſquare of HA, that is, as 2 to 1; hence the former of theſe circles will be double the latter, and conſequently one fourth of the former will be equal to one half of the latter; that is, the quadrant AECD will be equal to the ſemicircle ABC; from theſe equals take away the common ſpace bounded by the diameter AC and the arch AEC, and there will remain the triangle ADC equal to the lunular ſpace AECBA.

Squaring. Plate D. Fig. 1.

Although Hippocrates's diſcovery has led to no important concluſion either relating to the quadrature of the circle or that of any other curve, yet at the time it was made it might be regarded as of ſome conſequence, chiefly becauſe it ſhewed the poſſibility of exhibiting a rectilineal figure equal to a ſpace bounded by curve lines, a thing which we have reaſon to ſuppoſe was then done for the firſt time, and might have been fairly doubted, conſidering the inſuperable difficulty that was found to attend the quadrature of the circle or its rectification.

Ariſtotle ſpeaks of two perſons, viz. Bryſon and Antiphon, who about his time, or a little earlier, were occupied with the quadrature of the circle. The former appears, according to the teſtimony of Alexander Aprodiſeus, to have erred moſt egregiouſly; he having concluded that the circumference was exactly $3\frac{1}{4}$ times the diameter. And the latter ſeems to have proceeded pretty much in the ſame manner as Archimedes afterwards did in ſquaring the parabola, that is, by firſt inſcribing a ſquare in the circle, then an iſoſceles triangle in each of the ſegments of the curve, having for its baſe a ſide of the ſquare; and next again a ſeries of triangles in the ſegments, having for their baſes the ſides of the former ſeries, and ſo on: this mode of procedure however, could not be attended with any ſucceſs, as it is well known that the ſpaces thus formed do not, as in the caſe of the parabola, admit of being abſolutely ſummed.

It may naturally be ſuppoſed that Archimedes exerted his utmoſt efforts to reſolve this problem; and probably it was only after long meditation on the ſubject that he loſt all hopes of ſucceſs, and contented himſelf with that approximation to the ratio of the diameter to the circumference which is contained in his treatiſe *De Circuli Dimenſione*, which has been preſerved from the period in which he wrote, about 250 years before Chriſt, to the preſent times. He found his approximation to the ratio, by ſuppoſing a regular polygon of 96 ſides to be deſcribed about the circle, and another of the ſame number of ſides to be inſcribed in it, and by ſhewing that the perimeter of the circumſcribing polygon was leſs than $3\frac{10}{70}$, or $3\frac{1}{7}$ times the diameter, but that the perimeter of the inſcribed figure was greater than $3\frac{10}{71}$ times the

SQUARING or Quadrature of the Circle. Plate II.

Fig. 1.

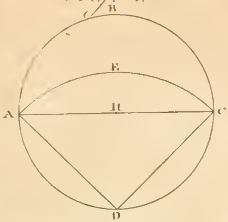
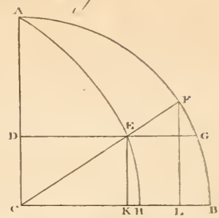


Fig. 2.



STARCH manufacture of.

Fig. 1.

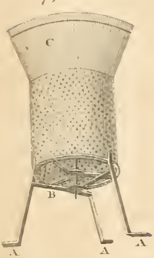


Fig. 6.

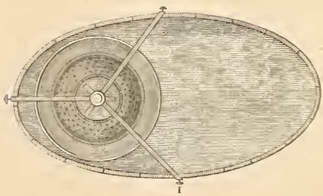


Fig. 4.

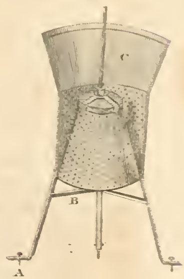


Fig. 2.

Fig. 7.

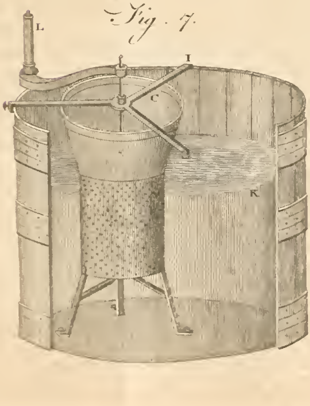


Fig. 5.

Fig. 3.

H. Tanner Sculpt

Squaring.

the diameter; now the circumference of the circle being lefs than the perimeter of the one polygon but greater than that of the other, it follows that the circumference muft be lefs than $3\frac{1}{7}$ times the diameter, but greater than $3\frac{10}{71}$ times; fo that, taking the firft of thefe limits as being expreffed by the fmalleft numbers, the circumference will be to the diameter as $3\frac{1}{7}$ to 1, or as 22 to 7 nearly.

Although the approximate ratio inveftigated by Archimedes be the oldeft known to have been found in the weftern world, yet one more accurate feems to have been known at a much earlier period in India. This we learn from the *Inftitutes of Akbar (Ayeen Akberry)* where it is faid that the Hindoos fuppofe the diameter of a circle to be to its circumference as 1250 to 3927. Now this ratio, which is the fame as that of 1 to 3.1416, when found in the fimpleft and moft elementary manner muft have required the infcription of a polygon of 768 fides in the circle, and muft have been attended with nine extractions of the fquare root, each carried as far as ten places of figures.

We learn from Simplicius that Nicomedes and Apollonius both attempted to fquare the circle, the former by means of a curve which he called the *Quadratrix*; the invention of which, however, is afcribed to Dinoftratus, and the latter alfo by the help of a curve denominated the fifter to the tortuous line or *fpiral*, and which was probably no other than the quadratrix of Dinoftratus; the nature of which, and the manner of its application to the fubject in queftion, we fhall briefly explain.

Fig. 2. Let AFB be a quadrant of a circle (fig. 2.) and C its centre; and conceive the radius CF to revolve uniformly about C from the pofition CA until at laft it coincide with CB; while at the fame time a line DG is carried with an uniform motion from A towards CB; the former line continuing always parallel to the latter, until at laft they coincide; both motions being fuppofed to begin and end at the fame inftant. Then the point E in which the revolving radius CF and the moveable line DG interfect one another will generate a certain curve line AEH, which is the *Quadratrix* of Dinoftratus.

Draw EK,FL both perpendicular to CB; then becaufe the radius AC and the quadrantal arch AFB are uniformly generated in the fame time by the points D and F, the contemporaneous fpaces defcribed will have to one another the fame ratio as the whole fpaces; that is, AD : AF : : AC : AB; hence we have AC : AB : : DC, or EK : FB. Now as the moveable point F approaches to B, the ratio of the ftraight line EK to the arch FB will approach to, and will manifeftly be ultimately the fame as the ratio of the ftraight line EK to the ftraight line FL, which again is equal to the ratio of CE to CF; therefore the ratio of the radius AC to the quadrantal arch AFB is the limit of the ratio of CE to CF, and confequently equal to the ratio of CH to CB, H being the point in which the quadratrix meets CB. Since therefore CH : CB : : CA or CB : quad. arch AFB, if by any means we could determine the point H, we might then find a ftraight line equal to the quadrantal arch, (by finding a third proportional to CH and CB) and confequently a ftraight line equal to the circumference. The point H, however, cannot be determined by a geometrical conftruction, and therefore all the ingenuity evinced by the perfon who firft thought of this method of rectifying the circle (which certainly is confiderable) has been unavailing.

The Arabs, who fucceeded the Greeks in the cultivation of the fciences, would no doubt have their pretended fquarers of the circle. We however know nothing more than that fome one of them believed he had difcovered that the diameter being unity, the circumference was the fquare root of 10; a very grofs miftake; for the fquare root of 10 exceeds 3.162; but Archimedes had demonftrated that the circumference was lefs than 3.143.

It appears that, even during the dark ages, fome attempts were made at the refolution of this famous problem, which however have always remained in manufcripts buried in the duft of old libraries. But upon the revival of learning the problem was again agitated by different writers, and particularly by the celebrated Cardinal De Cufa, who diftinguifhed himfelf by his unfortunate attempt to refolve it. His mode of inveftigation, which had no folid foundation in geometry, led him to conclude, that if a line equal to the fum of the radius of a circle and the fide of its infcribed fquare were made the diameter of another circle, and an equilateral triangle were infcribed in this laft, the perimeter of this triangle would be equal to the circumference of the other circle. This pretended quadrature of the cardinal's was refuted by Regiomontanus; and indeed the tafk was not difficult; for, according to his conftruction, the diameter being 1, the circumference was greater than $3\frac{1}{7}$; a conclufion which muft be abfurd, feeing that Archimedes had demonftrated that it muft be lefs than that number.

It would be trefpaffing too much upon the patience of our readers, were we to mention all the abfurd and erroneous attempts which have been made during the laft three centuries to fquare the circle. In a fupplement to Montucla's excellent work, *Hiftoire des Mathematiques*, we find upwards of forty pretenders to the honour of this difcovery enumerated. Thefe were almoft all very ignorant of geometry; and many of them were wild vifionaries, pretending to difcover inexplicable relations between the plain truths of mathematics and the moft myfterious doctrines of religion. If thofe who have fought the quadrature of the circle had been previoufly initiated in the doctrines of geometry, although they miffed attaining the object they had in view, yet they could not have failed to have extended the boundaries of the fcience by the difcovery of many new propofitions. From fuch perfons, however, as have generally purfued this inquiry, no improvement whatever of the fcience was to be expected; although, indeed, in fome inftances, it has derived advantage from the labours of fuch as have undertaken to expofe the abfurdity of their conclufions; as in the cafe of Metius, who in refuting the quadrature of one *Simon à Quercu*, found a much nearer approximation to the ratio of the diameter to the circumference than had been previoufly known, at leaft in Europe, viz. that of 113 to 355, which reduced to decimals is the fame as the ratio of 1 to 3.1415929, differing from the truth only in the feventh place of decimals.

Among the moft remarkable of thofe who have recorded their own folly by publifhing erroneous refolutions of the problem, we may reckon the celebrated Jofeph Scaliger. Full of felf-conceit, he believed that, entering

tering upon the ſtudy of geometry, he could not fail to ſurmount by the force of his genius thoſe obſtacles which had completely ſtopt the progreſs of all preceding inquirers. He gave the reſult of his meditations to the world in 1592, under the title *Nova Cyclometria ;* but he was refuted by Clavius, by Vieta, and others, who ſhewed that the magnitude he had aſſigned to the circumference was a little *leſs* than the perimeter of the inſcribed polygon of 192 ſides, which proved beyond a doubt that he was wrong. Scaliger, however, was not to be convinced of the abſurdity of his concluſion ; and indeed, in almoſt every inſtance, pretenders to this diſcovery have not been more remarkable for their folly in committing abſurd blunders, than for their obſtinacy in maintaining that they were in the right, and all who held a contrary opinion in an error.

The famous Hobbes came alſo upon the field about the year 1650, with pretenſions not only to the quadrature of the circle, but alſo to the triſection of an angle, the rectification of the parabola, &c. ; but his pretended ſolutions were refuted by Dr Wallis. And this circumſtance afforded him occaſion to write not only againſt geometers, but even againſt the ſcience of geometry itſelf.

We find it recorded by *Montucla*, as a ſort of phenomenon, that one Richard White, an Engliſh Jeſuit, having happened upon what he conceived to be a quadrature of the circle, which he publiſhed under the title, *Chryſaeſpis ſeu Quadratura Circuli*, ſuffered himſelf at laſt to be convinced by ſome of his friends that he was wrong both in his quadrature of the circle, and in his rectification of the ſpiral. But a ſolution of the ſame problem found out by one Mathulen of Lyons, did not produce in the end ſo much advantage to its author. This man in 1728 announced to the learned world that he had diſcovered both the quadrature of the circle and a perpetual motion ; and he was ſo certain of the truth of theſe diſcoveries, that he conſigned 1000 *ecus* (about 125l.) to be paid to any one who ſhould demonſtrate that he was deceived in either. The taſk was not difficult. Nicole of the Academy of Sciences demonſtrated that he was wrong, and he himſelf allowed it ; but he heſitated to pay the money, which Nicole had relinquiſhed in favour of the *Hotel Dieu* of Lyons. The affair went before a court of juſtice, which adjudged the money to be paid, as Nicole had deſtined it, to the poor. At a later period, viz. in 1753, the Chevalier de Cauſans, a French officer, and a man who was never expected to be a mathematician, ſuddenly found a quadrature of the circle in procuring a circular piece of turf to be cut ; and riſing from one truth to another, he explained by his quadrature the doctrine of original ſin, and the Trinity. He engaged himſelf by a public writing to depoſit with a notary the ſum of 300,000 francs, to be wagered againſt ſuch as ſhould oppoſe him, and he actually lodged 10,000, which were to devolve to him who ſhould demonſtrate his error. This was eaſily done, as it reſulted from his diſcovery that a circle was equal to its circumſcribing ſquare, that is, a part to the whole ! Some perſons came forward to anſwer his challenge, and in particular a young lady ſued him at one of the courts of law ; but the French king judged that the Chevalier's fortune ought not to ſuffer on account of his whim ; for, ſetting aſide this piece of folly, in every other reſpect he was a worthy man. The procedure was therefore ſtopt, and the wager declared void.

We ſhall not enter farther into the hiſtory of theſe vain and abſurd attempts to reſolve this important problem, but proceed to ſtate what has actually been done by men of ſound minds and real mathematical acquirements towards its ſolution. And in the firſt place it may be obſerved that the problem admits of being propoſed under two different forms : for it may be required to find either the area of the whole circle, or, which is the ſame thing, the length of the whole circumference ; or elſe to find the area of any propoſed ſector or ſegment, or, which is equivalent, the length of the arch of the ſector or ſegment. The former is termed the *definite* and the latter the *indefinite* quadrature of the circle. The latter evidently is more general than the former, and includes it as a particular caſe. Now if we could find by any means a finite algebraic equation that ſhould expreſs the relation between any propoſed arch of a circle, and ſome known ſtraight line, or lines, the magnitude of one or more of which depended on that arch, then we would have an abſolute rectification of the arch, and conſequently a rectification or quadrature alſo of the whole circle. We here ſpeak of an analytical ſolution of the problem ; the ancients, however, who were almoſt entirely ignorant of this branch of mathematical ſcience, muſt have endeavoured to treat it entirely upon geometrical principles. It is now well known, however, that all geometrical problems may be ſubjected to analyſis ; and that it is only by ſuch a mode of proceeding they have in many caſes been reſolved.

With reſpect to the definite quadrature of the circle, it is commonly underſtood that no unexceptionable demonſtration of its impoſſibility has hitherto been publiſhed. It is true that James Gregory, in his *vera circuli et Hyperbolæ quadratura*, has given what he conſidered as ſuch a demonſtration ; but it has been objected to, particularly by Huygens, one of the beſt geometers of his time. We are, however, certain that the ratio of the diameter to the circumference, as alſo, that the ratio of the ſquare of the diameter to the ſquare of a ſtraight line equal to the circumference, cannot be expreſſed by rational numbers, for this has been ſtrictly demonſtrated by Lambert in the Berlin Memoirs for 1761. A demonſtration is alſo given in Legendre's *Geometrie*. As to the indefinite quadrature, if Newton's demonſtration of the 28th lemma of the firſt book of his *Principia* be correct, the thing ought to be abſolutely impoſſible. For the object of that propoſition is to prove that in no oval figure whatever, that returns into itſelf, can the area cut off by ſtraight lines at pleaſure be univerſally found by an equation of a finite dimenſion, and compoſed of a finite number of terms. If this be true, then it will be impoſſible to expreſs any ſector of a circle taken at pleaſure in finite terms. It is however to be remarked, that the accuracy of the reaſoning by which Newton has attempted to eſtabliſh the truth of the general propoſition has been queſtioned by no leſs a geometer than D'Alembert ; and indeed we know one oval curve, which returns into itſelf, and which according to Newton's propoſition ought therefore not to admit of an indefinite quadrature ; yet this is by no means the caſe, for it does really admit of ſuch a quadrature. The curve we mean is the *lemniſcata*, the equation of which is $(x^2+y^2)^2=a^2(x^2-y^2)$, where x and y denote its coordinates,

ordinates, and a is put for a given line. The figure of the curve is nearly that of the numeral character 8. Upon the whole then we may infer that an unexceptionable demonftration of the impoffibility of expreffing either the whole circle, or any propofed fector of it, by a finite equation, is ftill among the *defiderata* of mathematics.

We come now to fpeak of the different methods which have been found for approximating to the area or to the circumference. We have already noticed the approximation to the ratio of the diameter to the circumference found by Archimedes, and the earlier and more accurate approximation of the Indian mathematicians. Archimedes's ratio is the only one found by the ancients in the weftern world that has defcended to modern times, and it appears to have been the moft accurate known, until about the year 1585, when Metius, in refuting a pretended quadrature, found the more accurate ratio of 113 to 355, as we have already noticed. About the fame time Vieta, and Adrianus Romanus publifhed their ratios expreffed in decimals, the former carrying the approximation to ten decimals inftead of fix, (which was the number of accurate figures expreffed by Metius's ratio), and the latter extending it to 17 figures. Vieta alfo gave a kind of feries, which being continued to infinity, gave the value of the circle.

Thefe approximations, however, were far exceeded by that of Ludolph Van Ceulen, who in a work publifhed in Dutch in 1610, carried it as far as 36 figures, fhowing that if the diameter were unity, the circumference would be greater than 3.14159,26535,89793, 23846,26433,83279,50288, but lefs than the fame number with the laft figure increafed by an unit. This work was tranflated into Latin by Snellius, and publifhed under the title, *De Circulo et Adfcriptis*. In finding this approximation, Van Ceulen followed the method of Archimedes, doubling continually the number of fides of the infcribed and circumfcribed polygons, until at length he found two which differed only by an unit in the 36th place of decimals in the numbers expreffing their perimeters. This, however, muft have been rather a work of patience than of genius; and indeed the labour muft have been prodigious. He feems to have valued highly this fingular effort, for in imitation of Archimedes, whofe tomb was adorned with a fphere and cylinder, in commemoration of his difcovery of the proportion which thefe folids bear to one another, he requefted that the ratio he had found might be infcribed on his tomb, which was accordingly done.

Snellius found means to abridge greatly the labour of calculation by fome very ingenious theorems; and although he did not go beyond Van Ceulen, yet he verified his refult. His difcoveries on this fubject are contained in a work called *Willebrordi Snellii Cyclometricus de Circuli Dimenfione*, &c. *Lugd. Bat.* 1621.

Defcartes found alfo a geometrical conftruction, which being repeated continually, gave the circumference, and from which he might eafily have deduced an expreffion in the form of a feries.

Gregory of St Vincent diftinguifhed himfelf alfo on this fubject. It is true he committed a great error in fuppofing he had difcovered the quadrature of both the circle and hyperbola; but he had previoufly made fo many beautiful geometrical difcoveries, deduced with much elegance after the manner of the ancients, that it would be wrong to number him with thofe abfurd pretenders which we have already noticed. Gregory's miftake was the caufe of a fharp controverfy carried on between his difciples on the one fide, and by Huygens, Merfennus and Leftaud on the other; and it was this that gave Huygens occafion to confider particularly the quadrature of the circle, and to inveftigate various new and curious theorems relating to it, which are contained in his *Theoremata de Quadratura Hyperboles, Ellipfis et Circuli*, 1651; and in his work *De Circuli Magnitudine Inventa*, 1654. In particular he fhowed, that if c denote the chord of an arch, and s its fine, then the arch itfelf will be greater than $c+\frac{1}{3}(c-s)$, but lefs than $c+\frac{4c+s}{2c+3s}\times\frac{1}{3}(c-s)$: he alfo fhowed that the arch is lefs than the fum of $\frac{2}{3}$ of its fine and $\frac{1}{3}$ of its tangent. Thefe theorems greatly fhorten the labour of approximating to the ratio of the diameter to the circumference, by means of infcribed and circumfcribed figures, infomuch that by the infcribed polygons of 6 and 12 fides, we may obtain it to the fame degree of accuracy as Archimedes did by the infcribed and circumfcribed polygons of 96 fides.

James Gregory, in his *Vera Circuli et Hyperbolæ Quadratura*, gave feveral curious theorems upon the relation of the circle to its infcribed and circumfcribed polygons, and their ratios to one another; and by means of thefe he found with infinitely lefs trouble than by the ordinary methods, and even by thofe of Snellius, the meafure of the circle as far as 20 places of figures. He gave alfo, after the example of Huygens, conftructions for finding ftraight lines nearly equal to arches of a circle, and of which the degree of accuracy was greater. For example, he found that if A be put for the chord of an arch of a circle, and B for twice the chord of half the arch, and C be taken fuch that A+B : B : : 2 B : C, then the arch itfelf is nearly equal to $\frac{8C+8B-A}{15}$, but a little lefs, the error in the cafe of a complete femicircle being lefs than its $\frac{1}{3500}$ part; and when the arch does not exceed 120°, it is lefs than its $\frac{1}{40000}$ part; and finally, for a quadrant the error is not greater than its $\frac{1}{300000}$ part. And farther, that if D be fuch that A : B : : B : D, then the arch is nearly equal to $\frac{12C+4B-D}{15}$, but a little greater, the error in the femicircle being lefs than its $\frac{1}{1000}$ part, and in a quadrant lefs than its $\frac{1}{60000}$ part.

The difcoveries of Dr Wallis, delivered in his *Arithmetica Infinitorum* publifhed in 1655, led him to a fingular expreffion for the ratio of the circle to the fquare of its diameter. He found that the former was to the latter as 1 to the product

$$\frac{3\times3\times5\times5\times7\times7\times9\times9\times11\times11\ \&c.}{2\times4\times4\times6\times6\times8\times8\times10\times10\times12}$$

the fractions $\frac{1}{2}$, $\frac{1}{4}$, $\frac{5}{4}$, $\frac{5}{6}$, &c. being fuppofed infinite in number. The products being fuppofed continued to infinity, we have the ratio exactly; but if we ftop at any finite number of terms, as muft neceffarily be the cafe in its application, the refult will be alternately too great and too fmall, according as we take an odd or an even number of terms of the numerator and denominator.

Thus

Thus the fraction $\frac{3}{2}$ is too great; on the other hand, $\frac{3\times 3}{2\times 4}=\frac{9}{8}$ is too small, and $\frac{3\times 3\times 5}{2\times 4\times 4}=\frac{45}{32}$ too great, and so on. But to approach as near as possible in each case, Wallis directs to multiply the product by the square root of a fraction formed by adding to unity the reciprocal of the last factor in either its numerator or denominator; then the result, although much nearer, will be too great if the number whose reciprocal is taken be the last in the numerator, but too small if it be the number in the denominator. Thus the following series of expressions will give approximate values of the infinite product $\frac{3\times 3\times 5\times 5\times 7\times 7\ \&c.}{2\times 4\times 4\times 6\times 6\times 8\times 8}$ which are alternately too great and too small.

$$\frac{3\cdot 3\cdot 5\cdot 5}{2.4.4.6}\sqrt{(1+\tfrac{1}{5})};\ \frac{3\cdot 3\cdot 5\cdot 5}{2.4.4.6}\sqrt{(1+\tfrac{1}{6})};$$

$$\frac{3\cdot 3\cdot 5\cdot 5\cdot 7\cdot 7}{2.4.4.6.6.8}\sqrt{1+\tfrac{1}{7})};\ \frac{3\cdot 3\cdot 5\cdot 5\cdot 7\cdot 7}{2.4.4.6.6.8}\sqrt{(1+\tfrac{1}{8})};\ \&c.$$

these values, alternately too great and too small, fall between the known limits.

An expression of another kind for the ratio of the circle to the square of the diameter was found by Lord Brounker. He showed that the circle being unity, the square of the diameter is expressed by the continued fraction

$$1+\cfrac{1}{2+\cfrac{9}{2+\cfrac{25}{2+\cfrac{49}{2+,\&c.}}}}$$

which is supposed to go on to infinity, the numerators 1, 9, 25, 49, &c. being the squares of the odd numbers 1, 3, 5, 7, &c. By taking two, three, four, &c. terms of this fraction, we shall have a series of approximate values which are alternately greater and less than its accurate value.

Such were the chief discoveries relating to the quadrature of the circle made before the time of Newton: many others, however, were quickly added by that truly great man, as well as by his contemporaries. In particular, Newton himself showed that if s denote the sine, and v the versed sine of an arch, then the radius being unity, the arch is equal to either of the following series,

$$s+\frac{1.s^3}{2.3}+\frac{1.3\,s^5}{2.4.5}+\frac{1.3.5\,s^7}{2.4.6.7}+\frac{1.3.5.7\,s^9}{2.4.6.8.9}+\ \&c.$$

$$\sqrt{2v}\times\left(1+\frac{1.v}{2.3.2}+\frac{1.3\,v^2}{2.4.5.2^2}+\frac{1.3.5\,v^3}{2.4.6.7.2^3}+\frac{1.3.5\,7\,v^4}{2\,4.6.8.9.2^4}+\ \&c.\right)$$

And James Gregory found that t being put for the tangent, the arch is expressed by the very simple series

$$t-\frac{t^3}{3}+\frac{t^5}{5}-\frac{t^7}{7}+\frac{t^9}{9}-\ \&c.$$

We have investigated the first of these series at § 140, and the third at § 137, of the article FLUXIONS: the second is easily obtained from the first by considering that since the sine of an arch is half the chord of twice the arch, that is, half of a mean proportional between the diameter and versed sine of twice the arch; we have therefore only to multiply the first series by 2, and to substitute $\frac{1}{2}\sqrt{2v}$ instead of s, and we get the second series.

By taking $s=\frac{1}{2}$, then, because in this case the arch contains 30°, we have half the circumference to the radius 1, or the whole circumference to the diameter 1, expressed by the infinite series

$$3\ (1+\frac{1}{2.3.2^2}+\frac{1.3}{2.4.5.2^4}+\frac{1.3.5}{2.4.6.7.2^6}+\frac{1.3.5.7}{2.4.6.8.9.2^8}+\ \&c.)$$

And by supposing that in the third series $t=1$, in which case the arch is one-eighth of the circumference, we have the same things expressed by the series

$$4\ (1-\frac{1}{3}+\frac{1}{5}-\frac{1}{7}+\frac{1}{9}-\frac{1}{11}+\ \&c.)$$

which was given by Leibnitz as a quadrature of the circle in the Leipsic Acts in the year 1682; but was discovered by him 1673. Gregory, however, had found the series under its general form several years before. By the first of these two numeral series we can readily compute the circumference of the circle to a tolerable degree of accuracy; but the second is altogether inapplicable in its present form on account of the slowness of its convergency; for Newton has observed that to exhibit its value exact to twenty places of figures, there would be occasion for no less than five thousand millions of its terms, to compute which would take up above a thousand years.

The slowness of the convergency has arisen from our supposing $t=1$. If we had supposed t greater than 1, then the series would not have converged at all, but on the contrary diverged. But by giving to t a value less than 1, then the rate of convergency will be increased, and that so much the more, as t is smaller.

If we suppose the arch of which t is the tangent to be 30°, then t will be $\sqrt{\frac{1}{3}}=\frac{1}{3}\sqrt{3}$, and therefore half the circumference to radius unity, or the circumference to the diameter unity, which in this case is $6t\ (1-\frac{t^2}{3}+\frac{t^4}{5}-\frac{t^6}{7}+\frac{t^8}{9}-\ \&c.)$ will be

$$\sqrt{12}\ (1-\frac{1}{3\cdot 3}+\frac{1}{5\cdot 3^2}-\frac{1}{7\cdot 3^3}+\frac{1}{9\cdot 3^4}-\ \&c.).$$

By means of this series, in an hour's time the circumference may be found to be nearly 3.141592653590, which is true to 11 decimal places, and is a very considerable degree of accuracy, considering the smallness of the labour. But Mr Machin, enticed by the easiness of the process, was induced, about the beginning of the last century, to continue the approximation as far as 100 places of figures, thus finding the diameter to be to the circumference as 1 to 3.14159.26535,89793, 23846,26433.83279,50288,41971,69399,37510,58209 74944,59230,78164,06286,20899,86280,34825,34211 70680. After him, De Lagny continued it as far as 128

Squaring.

128 figures. But he has alſo been outdone; for in Radcliffe's library at Oxford, there is a manuſcript in which it is carried as far as 150 figures!

Although this laſt ſeries, which was firſt propoſed by Dr Halley, gives the ratio of the diameter to the circumference with wonderful facility when compared with the operoſe method employed by Van Ceulen, yet others have been ſince found which accompliſh it with ſtill greater eaſe. In Halley's ſeries we have to compute the irrational quantity $\sqrt{12}$, becauſe of the irrational value which it was neceſſary to give to t in order to render it ſufficiently ſmall, and at the ſame time an exact part of the whole circumference; but Mr Machin contrived, by a very ingenious artifice, to reduce the computation of an arch of 45°, and conſequently the length of the whole circumference, to two ſeries which contain only rational quantities, and which at the ſame time converge with great rapidity. The nature of this artifice, and the manner in which it occurred to its author, is explained by Dr Hutton in his very excellent treatiſe on Menſuration, as follows: "Since the chief advantage (in the application of Gregory's ſeries to the rectification of the circle) conſiſts in taking ſmall arches, whoſe tangents ſhall be numbers eaſy to manage, Mr Machin very properly conſidered, that ſince the tangent of 45° is 1, and that the tangent of any arch being given, the tangent of the double of that arch can eaſily be had; if there be aſſumed ſome ſmall ſimple number as the tangent of an arch, and then the tangent of the double arch be continually taken, until a tangent be found nearly equal to 1, which is the tangent of 45°, by taking the tangent anſwering to the ſmall difference of 45° and this multiple, there would be found two very ſmall tangents, viz. the tangent firſt aſſumed, and the tangent of the difference between 45° and the multiple arch; and that therefore the lengths of the arches correſponding to theſe two tangents being calculated, and the arch belonging to the tangent firſt aſſumed being ſo often doubled as the multiple directs, the reſult, increaſed or diminiſhed by the other arch, according as the multiple ſhould be below or above it, would be the arch of 45°.

"Having thus thought of his method, by a few trials he was lucky enough to find a number (and perhaps the only one) proper for his purpoſe; viz. knowing that the tangent of $\frac{1}{4}$ of 45° is nearly $=\frac{1}{5}$, he aſſumed $\frac{1}{5}$ as the tangent of an arch. Then, ſince if t be the tangent of an arch, the tangent of the double arch will be $\frac{2t}{1-t^2}$, the radius being 1; the tangent of the double arch to that of which $\frac{1}{5}$ is the tangent will $\frac{5}{12}$, and the tangent of the double of this arch will be $\frac{120}{119}$, which being very nearly equal to 1, ſhews, that the arch which is equal to four times the firſt arch is very near 45°. Then, ſince the tangent of the difference between an arch of 45°, and an arch greater than 45°, whoſe tangent is T, is $\frac{T-1}{T+1}$, we ſhall have the tangent of the difference between 45°, and the arch whoſe tangent is $\frac{120}{119}$ equal to $\frac{1}{239}$. Now, by calculating from the general ſeries the arches whoſe tangents are $\frac{1}{5}$ and $\frac{1}{239}$, (which may be quickly done by reaſon of the ſmallneſs and ſimplicity of the numbers), and taking the latter arch from four times the former, the remainder will be the arch of 45°."

If we ſubſtitute $\frac{1}{5}$ inſtead of t in the general ſeries, we ſhall have the arch whoſe tangent is $\frac{1}{5}$ expreſſed by the ſeries $\frac{1}{5}-\frac{1}{3\cdot 5^3}+\frac{1}{5\cdot 5^5}-\frac{1}{7\cdot 5^7}+$, &c.; and, in like manner, by ſubſtituting $\frac{1}{239}$ for t, we get the arch whoſe tangent is $\frac{1}{239}$ expreſſed by the ſeries $\frac{1}{239}-\frac{1}{3\cdot 239^3}+\frac{1}{5\cdot 239^5}-\frac{1}{7\cdot 239^7}+$, &c. Now, ſince four times the arch to tan. $\frac{1}{5}$ diminiſhed by the arch to tan. $\frac{1}{239}$ is equal to the arch to tan. 1, that is, to the arch of 45°, or $\frac{1}{4}$ of the ſemicircumference; therefore, half the circumference of a circle to rad. $=1$, or the whole circumference, the diameter being 1, is equal to

$$16\left(\frac{1}{5}-\frac{1}{3\cdot 5^3}+\frac{1}{5\cdot 5^5}-\frac{1}{7\cdot 5^7}+\frac{1}{9\cdot 5^9}-, \text{\&c.}\right)$$
$$-4\left(\frac{1}{239}-\frac{1}{3\cdot 239^3}+\frac{1}{5\cdot 239^5}-\frac{1}{7\cdot 239^7}+\frac{1}{9\cdot 239^9}-, \text{\&c.}\right)$$

and this is Machin's ſeries for the rectification of the circle.

The happy idea which Machin had conceived of reducing the rectification of the arch whoſe tangent is unity to that of two arches whoſe tangents are ſmall rational fractions, having each unity for a numerator, appears alſo to have occurred to Euler; and the ſame thought has, ſince his time, been purſued by other mathematicians, who have contrived to reſolve an arch of 45° into three or more ſuch arches. We ſhall ſhew how this may be done, beginning with the inveſtigation of the following problem.

Problem. Suppoſing n, x, and y, to denote three whole numbers, ſuch, that the arch whoſe tangent is $\frac{1}{n}$ is equal to the ſum of two arches whoſe tangents are $\frac{1}{x}$ and $\frac{1}{y}$, radius being unity, it is required to determine all poſſible values of the numbers x and y in terms of the number n.

Solution. It is manifeſt from the formula for the tangent of the ſum of two arches (Algebra, § 368.) that $\frac{1}{n}=\frac{\frac{1}{x}+\frac{1}{y}}{1-\frac{1}{xy}}$; hence we have $\frac{1}{n}=\frac{x+y}{xy-1}$, and $nx+ny=xy-1$, and $y(x-n)=nx+1$; and, laſtly, $y=\frac{nx+1}{x-n}=n+\frac{n^2+1}{x-n}$. Now, as by hypotheſis, y is a whole number, it is manifeſt that $\frac{n^2+1}{x-n}$ muſt be a whole number; therefore, $x-n$ muſt be a diviſor of n^2+1. Let p be any diviſor of n^2+1, and q the quotient, that is, let $pq=n^2+1$, then $x-n=p$, and $x=n+p$: And ſince $\frac{n^2+1}{x-n}=\frac{pq}{p}=q$, therefore $y=n+q$; thus the values of x and y are determined in terms of n as required; and by giving to p and q all poſſible values, we ſhall have all the values of x and y that can exist. This solution affords us the following theorem.

THEOREM. Let n denote any whole number, and let n^2+1 be resolved into any two factors p and q, (one of which may be unity), that is, let $pq=n^2+1$; the arch whose tangent is $\frac{1}{n}$ is equal to the sum of the arches whose tangents are $\frac{1}{n+p}$, and $\frac{1}{n+q}$ respectively.

For the sake of brevity, let $A\frac{1}{n}$ be put to denote the arch, having for its tangent $\frac{1}{n}$; then, according to this notation, our theorem will be expressed thus, $A\frac{1}{n}= A\frac{1}{n+p}+A\frac{1}{n+q}$. Let us now suppose $n=1$, then $n^2+1=2=1\times 2$, therefore, the only values which we can give in this case to p and q are $p=1$, $q=2$, and these being substituted, we have

$$A\,1=A\tfrac{1}{2}+A\tfrac{1}{3}.$$

From which it appears, that the arch whose tangent is unity (that is, $\frac{1}{8}$ of the circumference), is the sum of the arches whose tangents are $\frac{1}{2}$ and $\frac{1}{3}$. This is Euler's theorem, and by means of it, putting $\frac{1}{2}$ and $\frac{1}{3}$ for t in the general series $t-\frac{1}{3}t^3+\frac{1}{5}t^5-\frac{1}{7}t^7+$, &c. we get half the circumference to radius 1 equal to

$$4\left\{\begin{array}{l}\frac{1}{2}-\frac{1}{3\cdot 2^3}+\frac{1}{5\cdot 2^5}-\frac{1}{7\cdot 2^7}+\frac{1}{9\cdot 2^9}-\text{, \&c.}\\ +\frac{1}{3}-\frac{1}{3\cdot 3^3}+\frac{1}{5\cdot 3^5}-\frac{1}{7\cdot 3^7}+\frac{1}{9\cdot 3^9}-\text{, \&c.}\end{array}\right\}$$

Let us now suppose $n=2$, then $n^2+1=5=1\times 5$, hence the only values which p and q can have are 1 and 5; and in this case our general formula gives $A\frac{1}{2}=A\frac{1}{3}+A\frac{1}{7}$.

If now from the two equations

$$A\,1=A\tfrac{1}{2}+A\tfrac{1}{3};\qquad A\tfrac{1}{2}=A\tfrac{1}{3},+A\tfrac{1}{7},$$

we eliminate successively $A\frac{1}{2}$ and $A\frac{1}{3}$, we shall obtain the two following:

$$A\,1=2\,A\tfrac{1}{3}+A\tfrac{1}{7};\qquad A\,1=2\,A\tfrac{1}{2}-A\tfrac{1}{7}.$$

From the first of these it appears that $\frac{1}{8}$ of the circumference is equal to the sum of twice the arch to tan. $\frac{1}{3}$, and once the arch to tan. $\frac{1}{7}$; and from the second, that the same quantity is equal to the excess of twice the arch to tan. $\frac{1}{2}$ above the arch to tan. $\frac{1}{7}$; and from each of these, an expression for the whole circumference may be obtained analogous to that which we have found above from Euler's formula, but which will converge faster, and therefore is better.

The resolution of an arch of 45° into three other arches, may be effected by means of our general formula, as follows: Put $n=3$, then $n^2+1=10=1\times 10=2\times 5$, hence we have $p=1$, and $q=10$, and also $p=2$, and $q=5$; therefore, substituting, we get two different values of $A\frac{1}{3}$, viz.

$$A\tfrac{1}{3}=A\tfrac{1}{4}+A\tfrac{1}{13};\qquad A\tfrac{1}{3}=A\tfrac{1}{5}+A\tfrac{1}{8}.$$

From these, and the equation $A\,1=2\,A\frac{1}{3}+A\frac{1}{7}$, we get, by exterminating $A\frac{1}{3}$, the two following expressions for $A\,1$, an arch of 45°.

$$A\,1=2\,A\tfrac{1}{4}+A\tfrac{1}{7}+2\,A\tfrac{1}{13};\quad A\,1=2\,A\tfrac{1}{5}+A\tfrac{1}{7}+2A\tfrac{1}{8}.$$

These give each an expression for the circumference composed of three series. The labour, however, of computing by either of them, particularly the latter, will probably be less than by any of the formulas composed of two series, on account of the greater degree of quickness with which the series will converge. All the preceding formulas have been investigated in different ways by different mathematicians. That, however, which we are about to investigate, we believe is new. Let n in the general formula be taken equal to 5; then $n^2+1=26=1\times 26=2\times 13$, therefore $p=1$, $q=26$, also $p=2$, $q=13$, hence we find $A\frac{1}{5}=A\frac{1}{6}+A\frac{1}{31}$, and also $A\frac{1}{5}=A\frac{1}{7}+A\frac{1}{18}$. From this last equation, and the equation $A\,1=2\,A\frac{1}{5}+A\frac{1}{7}+2\,A\frac{1}{8}$, let $A\frac{1}{5}$ be eliminated, and the result is

$$A\,1=3\,A\tfrac{1}{7}+2\,A\tfrac{1}{8}+2\,A\tfrac{1}{18}.$$

This appears to be the most convenient expression of any we have yet found, because the fractions are smaller, while at the same time two of the denominators consist of only one figure, and the third, which consists of two, admits of being resolved into factors. By the same mode of reasoning we have found this expression

$$A1=2A\tfrac{1}{8}+3A\tfrac{1}{9}+2A\tfrac{1}{18}+3A\tfrac{1}{32},$$

which consists of four terms; but for the sake of brevity we omit its investigation.

We shall now apply the formula $A1=3A\frac{1}{7}+2A\frac{1}{8}+2A\frac{1}{18}$ to the actual calculation of the arch of 45°, the radius of the circle being unity.

I. Calculation of the length of the arch whose tangent is $\frac{1}{7}$.

In this case, because $t=\frac{1}{7}$, we have

$$A\frac{1}{7}=\frac{1}{7}-\frac{1}{3\cdot 7^3}+\frac{1}{5\cdot 7^5}-\frac{1}{7\cdot 7^7}+\frac{1}{9\cdot 7^9}-\text{, \&c.}$$

$\frac{1}{7}$ =.1428571428571	$\frac{1}{3\cdot 7^3}$=.0009718172983
$\frac{1}{5\cdot 7^5}$=.0000118998037	$\frac{1}{7\cdot 7^7}$=.0000001734665
$\frac{1}{9\cdot 7^9}$=.0000000027534	$\frac{1}{11\cdot 7^{11}}$=.0000000000460
$\frac{1}{13\cdot 7^{13}}$=.0000000000008	.0009719908108

+.1428690454150 amount of positive terms.
—.0009719908108 amount of negative terms.

$A\frac{1}{7}$=.1418970546042

II. Calculation of the length of the arch whose tangent is $\frac{1}{8}$.

Here $t=\frac{1}{8}$, therefore,

$$A\frac{1}{8}=\frac{1}{8}-\frac{1}{3\cdot 8^3}+\frac{1}{5\cdot 8^5}-\frac{1}{7\cdot 8^7}+\text{, \&c.}$$

$\frac{1}{8}$

Squaring.

$$\frac{1}{8} = .1250000000000 \qquad \frac{1}{3.8^3} = .0006510416667$$
$$\frac{1}{5.8^5} = .0000061035156 \qquad \frac{1}{7.8^7} = .0000000681196$$
$$\frac{1}{9.8^9} = .0000000008278 \qquad \frac{1}{11.8^{11}} = .0000000000106$$
$$\frac{1}{13.8^{13}} = .0000000000001 \qquad .0006511097969$$

$$+.1250061043435$$
$$-.0006511097969$$

$$A\frac{1}{8} = .1243549945466$$

III. Calculation of the arch whofe tangent is $\frac{1}{18}$.

Here $t = \frac{1}{18}$, therefore,

$$A\frac{1}{18} = \frac{1}{18} - \frac{1}{3.18^3} + \frac{1}{5.18^5} - \frac{1}{7.18^7} +, \&c.$$

$$\frac{1}{18} = .0555555555556 \qquad \frac{1}{3.18^3} = .0000571559214$$
$$\frac{1}{5.18^5} = .0000001058443 \qquad \frac{1}{7.18^7} = .0000000002333$$
$$\frac{1}{9.18^9} = .0000000000006 \qquad .0000571561547$$

$$+.0555556614005$$
$$-.0000571561547$$

$$A\frac{1}{18} = .0554985052458$$

$$3A\tfrac{1}{7} = .4256911638126$$
$$2A\tfrac{1}{8} = .2487099890932$$
$$2A\tfrac{1}{18} = .1109970104916$$

$\frac{1}{8}$ of the circum. or $A1 = .785398163397$

Thus by a very eafy calculation we have obtained one-fourth of the circumference true to 12 decimal places; and indeed by this method we may find an approximate value of the ratio of the diameter to the circumference to 200 places of figures with, perhaps, as much eafe as Vieta or Romanus found it to 10 or 15 figures. We have already obferved that Van Ceulen defired that his quadrature, which extended only to 35 decimals, might be infcribed on his tomb; from which we may reafonably infer that the time and labour he had beftowed in the calculation muft have been very great; but by an artifice of the kind we have been explaining, Euler in 18 hours verified Lagny's quadrature of 128 figures.

In concluding this article we fhall briefly notice fome feries for the indefinite rectification of the circle, which have juft appeared in the fixth volume of the Edinburgh Philofophical Tranfactions. They are given by Mr W. Wallace of the Royal Military College, in a paper entitled, *New Series for the Quadrature of the Conic Sections, and the Computation of Logarithms*. Thefe feries do not give the arch directly, but only its reciprocal, or the powers of that reciprocal; it is however evident, that any one of thefe being known, the arch itfelf becomes immediately known. The firft feries is as follows. Let a denote any arch of a circle, and let its tangent, the tangents of its half, &c. be briefly denoted by tan. a, tan $\frac{1}{2}a$, &c. Then fhall

$$\frac{1}{a} = \frac{1}{\tan. a} + \tfrac{1}{2}\tan.\tfrac{1}{2}a + \tfrac{1}{4}\tan.\tfrac{1}{4}a + \tfrac{1}{8}\tan.\tfrac{1}{8}a.$$
$$+ \tfrac{1}{16}\tan.\tfrac{1}{16}a \ldots\ldots + T + T' + S.$$

Here the arches a, $\frac{1}{2}a$, $\frac{1}{4}a$, $\frac{1}{8}a$, &c. conftitute a geometrical progreffion, having the number of its terms infinite, and their common ratio $\frac{1}{2}$. The letters T and T′ are put for any two adjoining terms (after the firft) of the feries, and S is put for the fum of all the terms following thefe; and this fum is always contained between two limits, one of which is $\frac{1}{3}$ of the latter of the two terms T, T′, and the other is a third proportional to their difference; and the laft of the two being always lefs than the firft of thefe limits, but greater than the fecond. As a fpecimen of the way of applying this feries, we fhall give the calculation of the length of an arch of 90° to fix decimal places. In this cafe $\frac{1}{\tan. a}$ $=$ cotan. $a = 0$, tan. $\frac{1}{2}a = 1$, the remaining quantities tan. $\frac{1}{4}a$, tan. $\frac{1}{8}a$, &c. are to be computed from tan. $\frac{1}{2}a$ by this formula, tan. $\frac{1}{2}A = \sqrt{\left(\frac{1}{\tan.^2 A} + 1\right)} - \frac{1}{\tan. A}$.

Accordingly we find

$$\tan.\tfrac{1}{2}a = 1. \qquad \tan.\tfrac{1}{16}a = .0984914$$
$$\tan.\tfrac{1}{4}a = .4142136 \qquad \tan.\tfrac{1}{32}a = .0491268$$
$$\tan.\tfrac{1}{8}a = .1989123 \qquad \tan.\tfrac{1}{64}a = .0245486$$

$$\tfrac{1}{2}\tan.\tfrac{1}{2}a = .5000000$$
$$\tfrac{1}{4}\tan.\tfrac{1}{4}a = .1035534$$
$$\tfrac{1}{8}\tan.\tfrac{1}{8}a = .0248640$$
$$\tfrac{1}{16}\tan.\tfrac{1}{16}a = .0061557$$
$$T = \tfrac{1}{32}\tan.\tfrac{1}{32}a = .0015352$$
$$T' = \tfrac{1}{64}\tan.\tfrac{1}{64}a = .0003836$$
$$\left.\begin{array}{l} S < .0001278,7 \\ S > .0001277,7 \end{array}\right\} \text{Hence } S = .0001278$$

$$\frac{1}{a} = .6366197$$
Arch of $90° = a = 1.570796$.

The fecond feries given in this paper is expreffed as follows. Let cof. a, cof. $\frac{1}{2}a$, &c. denote the cofine of the arch, the cofine of its half, &c. Then

$$\frac{1}{a^2} = \frac{1}{4}\,\frac{1 + \text{cof. } a}{1 - \text{cof. } a} + \frac{1}{6}$$
$$-\left(\frac{1}{4^2}\,\frac{1 - \text{cof. }\frac{1}{2}a}{1 + \text{cof. }\frac{1}{2}a} + \frac{1}{4^3}\,\frac{1 - \text{cof. }\frac{1}{4}a}{1 + \text{cof. }\frac{1}{4}a}\right.$$
$$\left. + \frac{1}{4^4}\,\frac{1 - \text{cof. }\frac{1}{8}a}{1 + \text{cof. }\frac{1}{8}a} \ldots\ldots + T + T' + S\right)$$

Here, as before, the letters T, T′ denote any two adjacent terms of the feries in the parenthefis, and S is put for the fum of all the following terms, which in this cafe is always lefs than $\frac{1}{15}$T′, but greater than a third proportional to T—T′ and T′. This fecond feries converges

verges quicker than the firft, and is befides better adapted to calculation, becaufe the cofines of the feries of arches $\frac{1}{2}a$, $\frac{1}{4}a$, &c. are more eafily deduced from the cofine of a and one another than the tangents. The formula in this cafe being $\text{cof.} \frac{1}{2} A = \sqrt{\left(\frac{1+\text{cof. } A}{2}\right)}$.

There are various other feries for the rectification of any arch of a circle given in the fame paper, fome of which converge fafter than either of the two we have here fpecified, and all have the property of being applicable to every poffible cafe, and of having very fimple limits, between which the fum of all their terms following any propofed term are always contained. It may alfo be obferved that the principles from which they are deduced are of the moft fimple and elementary kind, infomuch that the author has ftated it as his opinion, that their inveftigation might even be admitted into and form a part of the elements of geometry.

SQUATINA. See SQUALUS, ICHTHYOLOGY *Index*.

SQUILL. See SCILLA, BOTANY and MATERIA MEDICA *Index*.

SQUILLA, the name of a fpecies of cancer. See CANCER, ENTOMOLOGY *Index*.

SQUINTING. See MEDICINE, N° 383.

SQUIRREL. See SCIURUS, MAMMALIA *Index*.

STABBING, in *Law*. The offence of mortally ftabbing another, though done upon fudden provocation, is punifhed as murder; the benefit of clergy being taken away from it by ftatute. (See MURDER). For by Ja. I. c. 8. when one thrufts or ftabs another, not then having a weapon drawn, or who hath not then firft ftricken the party ftabbing, fo that he dies thereof within fix months after, the offender fhall not have the benefit of clergy, though he did it not of malice aforethought. This ftatute was made on account of the frequent quarrels and ftabbings with fhort daggers between the Scotch and the Englifh, at the acceffion of James I.; and being therefore of a temporary nature, ought to have expired with the mifchief which it meant to remedy. For, in point of folid and fubftantial juftice, it cannot be faid that the mode of killing, whether by ftabbing, ftrangling, or fhooting, can either extenuate or enhance the guilt; unlefs where, as in the cafe of poifoning, it carries with it internal evidence of cool and deliberate malice. But the benignity of the law hath conftrued the ftatute fo favourably in behalf of the fubject, and fo ftrictly when againft him, that the offence of ftabbing now ftands almoft upon the fame footing as it did at the common law. Thus, (not to repeat the cafes mentioned under MANSLAUGHTER, of ftabbing an adulterefs, &c. which are barely manflaughter, as at common law), in the conftruction of this ftatute it hath been doubted, whether, if the deceafed had ftruck at all before the mortal blow given, this does not take it out of the ftatute, though in the preceding quarrel the ftabber had given the firft blow; and it feems to be the better opinion, that this is not within the ftatute. Alfo it hath been refolved, that the killing a man, by throwing a hammer or other weapon, is not within the ftatute; and whether a fhot with a piftol be fo or not is doubted. But if the party flain had a cudgel in his hand, or had thrown a pot or a bottle, or difcharged a piftol at the party ftabbing, this is a fufficient reafon for having a weapon drawn on his fide within the words of the ftatute.

Blackft. Comment. vol. iv. p. 193.

STACHYS, HEDGE-NETTLE, or ALL-HEAL, a genus of plants belonging to the clafs of didynamia, and order of gymnofpermia; and in the natural fyftem arranged under the 42d order, *Verticillatæ*. See BOTANY *Index*.

STADIUM, an ancient Greek long meafure, containing 125 geometrical paces, or 625 Roman feet, correfponding to our furlong. The word is faid to be formed from the Greek word στασις "a ftation," or ιστημι "to ftand," becaufe it is reported that Hercules having run a ftadium at one breath, ftood ftill at the end of it. The Greeks ufually meafured diftances by ftadia, which they called σταδιασμος. Stadium alfo fignified the courfe on which their races were run.

STADTHOLDER, formerly the principal magiftrate or governor of the Seven United Provinces. Although this office is now abolifhed by the ufurped influence of France, our readers will probably not be ill pleafed with a fhort account of the feveral powers and claims connected with it. To render that account the more intelligible, we fhall trace the office of a ftadtholder from its origin.

The Seven Provinces of the Low Countries were long governed by princes invefted with the fovereignty, though limited in their powers, and under various titles; as *Counts of Holland*, *Dukes of Guelder*, *Bifhop of Utrecht*, &c. When thefe countries fell to the princes of the houfe of Burgundy, and afterwards to thofe of Auftria, who had many other dominions, the abfence of the fovereign was fupplied by a ftadtholder or governor, vefted with very ample powers. Thefe ftadtholders or lieutenants had the adminiftration of the government, and prefided in the courts of juftice, whofe jurifdiction was not at that time confined merely to the trial of caufes, but extended to affairs of ftate. The ftadtholders fwore allegiance to the princes at their inauguration, jointly with the ftates of the provinces they governed. They likewife took an oath to the ftates, by which they promifed to maintain their fundamental laws and privileges.

It was upon this footing that William the Firft, prince of Orange, was made governor and lieutenant-general of Holland, Zealand, and Utrecht, by Philip the Second, upon his leaving the Low Countries to go into Spain. The troubles beginning foon after, this prince found means to bring about an union, in 1576, between Holland and Zealand; the ftates of which two provinces put into his hands, as far as was in their power, the fovereign authority (for fo long time as they fhould remain in war and under arms), upon the fame footing as Holland had intrufted him with it the year before. In 1581 the fame authority was again renewed to him by Holland, as it was foon after by Zealand likewife; and in 1584, being already elected count of Holland, upon certain conditions he would have been formally invefted with the fovereignty, had not a wretch, hired and employed by the court of Spain, put an end to his life by a horrid affaffination.

In the preamble of the inftruments by which the ftates in 1581 conferred the fovereign authority upon Prince William the Firft, we find thefe remarkable words, which are there fet down as fundamental rules: "That all republics and communities ought to preferve

ferve, maintain, and fortify themfelves by unanimity; which being impoffible to be kept up always among fo many members, often differing in inclinations and fentiments, it is confequently neceffary that the government fhould be placed in the hands of one fingle chief magiftrate." Many good politicians, and the greateft part of the inhabitants of thefe provinces, fince the eftablifhment of the republic, looked upon the ftadtholderian government as an effential part of her conftitution; nor has fhe been without a ftadtholder but twice, that is to fay, from the end of 1650 to 1672, and again from March 1702 till April 1747. The provinces of Friefland and Groningen, with Ommelands, had always a ftadtholder without interruption: their inftructions may be feen in Aitzema; but formerly the powers of the ftadtholder of thefe provinces were confined within narrower bounds, and till William the Fourth there was no ftadtholder of the feven provinces together.

The ftadtholder could not declare war or make peace, but he had, in quality of captain-general of the union, the command in chief of all the forces of the ftate (A); and military perfons were obliged to obey him in every thing that concerned the fervice. He was not limited by inftructions; but he had the important power of giving out orders for the march of troops, and the difpofition of all matters relative to them. He not only directed their marches, but provided for the garrifons, and changed them at pleafure. All military edicts and regulations came from him alone; he conftituted and authorized the high council of war of the United Provinces, and, as captain general of every province, difpofed of all military offices, as far as the rank of colonel inclufively. The higher pofts, fuch as thofe of veltmarfhals, generals, lieutenant-generals, major-generals, were given by the ftates general, who chofe the perfons recommended by his highnefs. He made the governors, commandants, &c. of towns and ftrong places of the republic, and of the barrier. The perfons nominated prefented their inftruments of appointment to their high mightineffes, who provided them with commiffions. The ftates-general had likewife great regard to the recommendation of the prince ftadtholder in the difpofition of thofe civil employments which were in their gift.

The power of the ftadtholder as high-admiral, extended to every thing that concerned the naval force of the republic, and to all the other affairs that were here within the jurifdiction of the admiralty. He prefided at thefe boards either in perfon or by his reprefentatives; and as chief of them all in general, and of every one in particular, he had power to make their orders and inftructions be obferved by themfelves and others. He beftowed the pofts of lieutenant-admiral, vice-admiral, and rear-admiral, who commanded under him; and he made likewife poft-captains.

The ftadtholder granted likewife letters of grace, pardon, and abolition, as well for the crimes called *Communia Delicta*, as for military offences. In Holland and Zealand thefe letters were made out for crimes of the firft fort, in the name of the ftates, with the advice of his highnefs. In military offences he confulted the high council of war; and upon the *communia delicta* he took the advice of the courts of juftice, of the counfellors, committees of the provinces, of the council of ftate, and the tribunals of juftice in the refpective towns, according to the nature of the cafe.

In the provinces of Holland and Zealand, the ftadtholder elected the magiftrates of the towns annually, out of a double number that were returned to him by the towns themfelves.

When any of thefe offices became vacant, which, at the time there was no governor, were in the difpofal of the ftates of Holland, or as formerly in that of the chamber of accounts, the ftadtholder had his choice of two, or, in fome cafes, of three candidates, named by their noble and great mightineffes. He chofe likewife the counfellors, infpectors of the dykes of Rynland, Delfland, and Scheeland, out of three perfons prefented to him by the boards of the counfellors infpectors; which boards were of very ancient eftablifhment in Holland.

His highnefs prefided in the courts of Holland, and in the courts of juftice of the other provinces; and his name was placed at the head of the proclamations and acts, called in Dutch *Mandomenten*, or *Provifion van Juftitie*. In Overyffel and in the province of Utrecht the poffeffors of fiefs held of the prince ftadtholder. He was fupreme curator of the univerfities of Guelder, Friefland, and Groningen; grand forefter and grand veneur in Guelder, in Holland, and other places. In the province of Utrecht, his highnefs, by virtue of the regulation of 1674, difpofed of the provoftfhips and other benefices which remained to the chapters, as alfo of the canonical prebends that fell in the months which were formerly the papal months.

By the firft article of the council of ftate of the United Provinces, the ftadtholder was the firft member of it, and had a right of voting there, with an appointment of 25,000 guilders a-year. He affifted alfo, as often as he thought it for the fervice of the ftate, at the deliberations of the ftates-general, to make propofitions to them, and fometimes alfo at the conferences which the deputies of their high mightineffes held in their different committees, in confequence of their ftanding orders. He likewife affifted at the affemblies of the ftates of each particular province, and at that of the counfellors committees. In Guelder, Holland, and Utrecht, his highnefs had a fhare of the fovereignty, as chief or prefident of the body of nobles; and in Zealand, where he poffeffed the marquifate of Veer and Flufhing, as firft noble, and reprefenting the whole nobility. In his abfence he had

(A) In times of war, however, the ftates had always named deputies for the army, to accompany the ftadtholders in the field, and to ferve them as counfellors in all their enterprifes, particularly in the moft important affairs, fuch as giving battle, or undertaking a fiege, &c. This was always practifed till the acceffion of King William the Third to the crown of Great Britain, and after his death was continued with regard to the general in chief of the army of the republic. In 1747 and 1748 there were likewife deputies with the army, but with more limited power.

had in Zealand his reprefentatives, who had the firft place and the firft voice in all the councils, and the firft of whom was always firft deputy from the province to the affembly of their high mightineffes.

In 1749 the prince ftadtholder was created by the ftates-general, governor-general and fupreme director of the Eaft and Weft India companies; dignities which gave him a great deal of authority and power, and which had never been conferred upon any of his predeceffors, nor had they hitherto been made hereditary. He had his reprefentatives in the feveral chambers of the company, and chofe their directors out of a nomination of three qualified perfons. The prince enjoyed this prerogative in Zealand from the time of his elevation to the ftadtholderate.

The revenues of the ftadtholderate of the feven United Provinces were reckoned (including the 25,000 guilders which the prince enjoyed annually as the firft member of the council of ftate, and what he had from the India company's dividends) to amount to 300,000 guilders a-year. As captain-general of the union, his ferene highnefs had 120,000 guilders per annum; befides 24,000 from Friefland, and 12,000 from Groningen, in quality of captain-general of thofe provinces. In times of war the ftate allowed extraordinary fums to the captain-general for the expence of every campaign.

All thefe powers and privileges were held by the prince of Orange previous to the revolutionary war of France. The influence of the ufurper of that kingdom has extended to the ftates of Holland, and attached them as a province to France under the name of a kingdom, at the head of which is a brother of Bonaparte.

STÆHELINA, a genus of plants belonging to the clafs of fyngenefia, and order of polygamia æqualis; and in the natural fyftem arranged under the 49th order, *Compofitæ*. See BOTANY *Index*.

STAFF, an inftrument ordinarily ufed to reft on in walking. The ftaff is alfo frequently ufed as a kind of natural weapon both of offence and defence; and for feveral other purpofes.

STAFF, a light pole erected in different parts of a fhip, whereon to hoift and difplay the colours.

The principal of thefe is reared immediately over the ftern, to difplay the enfign; another is fixed on the bowfprit, to extend the jack; three more are erected at the three maft heads, or formed by their upper ends, to fhow the flag or pendant of the refpective fquadron or divifion to which the fhip is appropriated. See ENSIGN, MAST, JACK, and PENDANT.

STAFF, in military matters, confifts of a quarter-mafter-general, adjutant-general, and majors of brigade. The ftaff properly exifts only in time of war. See *QUARTER-Mafter General*, &c.

Regimental STAFF, confifts in the adjutant, quarter-mafter, chaplain, furgeon, &c.

STAFF, in mufic, five lines, on which, with the intermediate fpaces, the notes of a fong or piece of mufic are marked.

Fore-STAFF. See *FORE Staff*.

STAFFA, one of the Hebrides or Weftern Iflands of Scotland, remarkable for its bafaltic pillars. It was vifited by Sir Jofeph Banks, who communicated the following account of it to Mr Pennant.

"The little ifland of Staffa lies on the weft coaft of Mull, about three leagues north-eaft from Iona, or Icolumbkill: its greateft length is about an Englifh mile, and its breadth about half a one. On the eaft fide of the ifland is a fmall bay where boats generally land; a little to the fouthward of which the firft appearance of pillarsis to be obferved; they are fmall; and inftead of being placed upright, lie down on their fides, each forming a fegment of a circle. From thence you pafs a fmall cave, above which the pillars, now grown a little larger, are inclining in all directions: in one place in particular, a fmall mafs of them very much refembles the ribs of a fhip. From hence having paffed the cave, which, if it is not low-water, you muft do in a boat, you come to the firft ranges of pillars, which are ftill not above half as large as thofe a little beyond. Over againft this place is a fmall ifland, called in Erfe *Boo-fha-la*, feparated from the main by a channel not many fathoms wide. This whole ifland is compofed of pillars without any ftratum above them; they are ftill fmall, but by much the neateft formed of any about the place.

"The firft divifion of the ifland, for at high water it is divided into two, makes a kind of a cone, the pillars converging together towards the centre: on the other they are in general laid down flat: and in the front next to the main, you fee how beautifully they are packed together, their ends coming out fquare with the bank which they form. All thefe have their tranfverfe fections exact, and their furfaces fmooth; which is by no means the cafe with the large ones, which are cracked in all directions. I muft queftion, however, if any part of this whole ifland of Boo-fha-la is two feet in diameter.

"The main ifland oppofite to Boo-fha-la, and farther towards the north-weft, is fupported by ranges of pillars pretty erect, and, though not tall (as they are not uncovered to the bafe), of large diameters; and at their feet is an irregular pavement, made by the upper fides of fuch as have been broken off, which extends as far under water as the eye can reach. Here the forms of the pillars are apparent; thefe are of three, four, five, fix, and feven fides; but the numbers of five and fix are by much the moft prevalent. The largeft I meafured was of feven; it was four feet five inches in diameter.

"The furfaces of thefe large pillars, in general, are rough and uneven, full of cracks in all directions; the tranfverfe figures in the upright ones never fail to run in their true directions. The furfaces upon which we walked were often flat, having neither concavity nor convexity; the larger number, however, was concave, though fome were very evidently convex. In fome places, the interftices within the perpendicular figures were filled up with a yellow fpar: in one place, a vein paffed in among the mafs of pillars, carrying here and there fmall threads of fpar. Though they were broken and cracked through in all directions, yet their perpendicular figures might eafily be traced: from whence it is eafy to infer, that whatever the accident might have been that caufed the diflocation, it happened after the formation of the pillars.

"From hence proceeding along fhore, you arrive at Fingal's cave. Its dimenfions I have given in the form of a table:

	Feet.	In.
Length of the cave from the rock without,	371	6
From the pitch of the arch,	250	0

Breadth of ditto at the mouth,	53	7
At the farther end,	20	0
Height of the arch at the mouth,	117	6
At the end,	70	0
Height of an outside pillar,	39	6
Of one at the north-west corner,	54	0
Depth of water at the mouth,	18	0
At the bottom,	9	0

"The cave runs into the rock in the direction of north-east by east by the compass.

"Proceeding farther to the north-west, you meet with the highest ranges of pillars; the magnificent appearance of which is past all description. Here they are bare to their very basis, and the stratum below them is also visible: in a short time, it rises many feet above the water, and gives an opportunity of examining its quality. Its surface is rough, and has often large lumps of stone sticking in it as if half immersed: itself, when broken, is composed of a thousand heterogeneous parts, which together have very much the appearance of a lava; and the more so, as many of the lumps appear to be of the very same stone of which the pillars are formed. This whole stratum lies in an inclined position, dipping gradually towards the south-east. As hereabouts is the situation of the highest pillars, I shall mention my measurements of them, and the different strata in this place, premising, that the measurements were made with a line, held in the hand of a person who stood at the top of the cliff, and reaching to the bottom; to the lower end of which was tied a white mark, which was observed by one who staid below for the purpose: when this mark was set off from the water, the person below noted it down, and made signal to him above, who made then a mark in his rope: whenever this mark passed a notable place, the same signal was made, and the name of the place noted down as before: the line being all hauled up, and the distances between the marks measured and noted down, gave, when compared with the book kept below, the distances, as for instance in the cave:

"N° 1. in the book below, was called from the water to the foot of the first pillar in the book above; N° 1. gave 36 feet eight inches, the highest of that ascent, which was composed of broken pillars.

"N° 1. Pillar at the west corner of Fingal's cave.

	Feet.	In.
1 From the water to the foot of the pillar,	12	10
2 Height of the pillar,	37	3
3 Stratum above the pillar,	66	9

"N° 2. Fingal's cave.

1 From the water to the foot of the pillar,	36	8
2 Height of the pillar	39	6
3 From the top of the pillar to the top of the arch,	31	4
4 Thickness of the stratum above,	34	4
By adding together the three first measurements, we got the height of the arch from the water,	117	6

"N° 3. Corner pillar to the westward of Fingal's cave.

Stratum below the pillar of lava-like matter,	11	0
Length of pillar,	54	0
Stratum above the pillar,	61	6

"N° 4. Another part to the westward.

Stratum below the pillar,	17	1
Height of the pillar,	50	0
Stratum above.	51	1

"N° 5. Another pillar farther to the westward.

Stratum below the pillar,	19	8
Height of the pillar,	55	1
Stratum above,	54	7

"The stratum above the pillars, which is here mentioned, is uniformly the same, consisting of numberless small pillars, bending and inclining in all directions, sometimes so irregularly that the stones can only be said to have an inclination to assume a columnar form; in others more regular, but never breaking into or disturbing the stratum of large pillars, whose tops everywhere keep an uniform and regular line.

"Proceeding now along the shore round the north end of the island, you arrive at *Oua na scarve*, or the Corvorant's Cave. Here the stratum under the pillars is lifted up very high; the pillars above it are considerably less than those at the north-west end of the island, but still very considerable. Beyond is a bay, which cuts deep into the island, rendering it in that place not more than a quarter of a mile over. On the sides of this bay, especially beyond a little valley, which almost cuts the island into two, are two stages of pillars, but small; however, having a stratum between them exactly the same as that above them, formed of innumerable little pillars, shaken out of their places, and leaning in all directions.

"Having passed this bay, the pillars totally cease; the rock is of a dark brown stone, and no signs of regularity occur till you have passed round the south-east end of the island (a space almost as large as that occupied by the pillars), which you meet again on the west side, beginning to form themselves irregularly, as if the stratum had an inclination to that form, and soon arrive at the bending pillars where I began.

"The stone of which the pillars are formed, is a coarse kind of basaltes, very much resembling the Giant's Causeway in Ireland, though none of them are near so neat as the specimens of the latter which I have seen at the British Museum; owing chiefly to the colour, which in ours is a dirty brown, in the Irish a fine black; indeed the whole production seems very much to resemble the Giant's Causeway."

STAFFORD, the county town of Staffordshire, in W. Long. 2. 0. N. Lat. 53. 0. It stands on the river Sow, has two parish-churches, a fine square market-place, and a flourishing cloth-manufacture. It sends two members to parliament, and is 135 miles from London.

STAFFORDSHIRE, a county of England, bounded on the south by Worcestershire, by Cheshire and Derbyshire on the north, by Warwickshire and Derbyshire on the east, and Shropshire and Cheshire on the west. The length is reckoned 62 miles, the breadth 33, and the circumference 180. It contains five hundreds, 150 parishes, 810,000 acres, 18 market-towns, and 239,153

239,153 inhabitants. The air, except in thofe parts that are called the Moorlands and Woodlands, and about the mines, is good, efpecially upon the hills, where it is accounted very fine. The foil in the northern mountainous parts is not fertile; but in the middle, where it is watered by the Trent, the third river in England, it is both fruitful and pleafant, being a mixture of arable and meadow grounds. In the fouth, it abounds not only with corn, but with mines of iron and pits of coal. The principal rivers of this county, befides the Trent, which runs almoft through the middle of it, and abounds with falmon, are the Dove and Tame, both of which are well ftored with fifh. In this county are alfo a great many lakes, and meres or pools, as they are called; which, having ftreams either running into them or from them, cannot be fuppofed to be of any great prejudice to the air; they yield plenty of fifh. In divers parts of the county are medicinal waters, impregnated with different forts of minerals, and confequently of different qualities and virtues; as thofe at Hints and Brefsford-houfe, which are mixed with bitumen; thofe at Ingeftre, Codfalwood, and Willoughbridge park, which are fulphureous. Of the faline kind are the Brine-pits at Chertley, Epfom, Penfnet-clofe, of which very good falt is made. There is a well at Newcaftle-under-Line that is faid to cure the king's evil; another called *Elder-well* near Blemhill, faid to be good for fore eyes; and a third called the *Spa*, near Wolverhampton.

Great flocks of fheep are bred in this county, efpecially in the moorlands, or mountains of the northern part of it; but the wool is faid to be fomewhat coarfer than that of many other counties. Of this wool, however, they make a variety of manufactures, particularly felts. In the low grounds along the rivers are rich paftures for black cattle; and vaft quantities of butter and cheefe are made. In the middle and fouthern parts not only grain of all kinds, but a great deal of hemp and flax are raifed. This country produces alfo lead, copper, iron; marble, alabafter, millftones, limeftone; coal, falt, and marles of feveral forts and colours; brick-earth, fullers earth, and potters clay, particularly a fort ufed in the glafs manufacture at Amblecot, and fold at feven-pence a bufhel; tobacco-pipe clay; a fort of reddifh earth called *flip*, ufed in painting divers veffels; red and yellow ochres; fire-ftones for hearths of iron furnaces, ovens, &c.; iron-ftones of feveral forts; blood-ftones, or hæmatites, found in the brook Tent, which, when wet a little, will draw red lines like ruddle; quarry-ftones, and grind-ftones. For fuel the country is well fupplied with turf, peat, and coal of feveral forts, as cannel-coal, peacock-coal, and pit-coal. The peacock-coal is fo called, becaufe, when turned to the light, it difplays all the colours of the peacock's tail; but it is fitter for the forge than the kitchen. Of the pit-coal there is an inexhauftible ftore: it burns into white afhes, and leaves no fuch cinder as that of the Newcaftle coal. It is not ufed for malting till it is charred, and in that ftate it makes admirable winter-fuel for a chamber.

This county is in the diocefe of Litchfield and Coventry, and the Oxford circuit. It fends ten members to parliament; namely, two for the county, two for the city of Litchfield, two for Stafford, two for Newcaftle-under-Line, and two for Tamworth.

STAG. See Cervus, Mammalia *Index*.

Stag-Beetle. See Lucanus, Entomology *Index*.

STAGE, in the modern drama, the place of action and reprefentation, included between the pit and the fcenes, and anfwering to the profcenium or pulpitum of the ancients. See Playhouse and Theatre.

STAGGERS. See Farriery *Index*.

STAHL, George Ernest, an eminent German chemift, was born in Franconia in 1660, and chofen profeffor of medicine at Hall, when a univerfity was founded in that city in 1694. The excellency of his lectures while he filled that chair, the importance of his various publications, and his extenfive practice, foon raifed his reputation to a very great height. He received an invitation to Berlin in 1716, which having accepted, he was made counfellor of ftate and phyfician to the king. He died in 1734, in the 75th year of his age. Stahl is without doubt one of the greateft men of which the annals of medicine can boaft: his name marks the commencement of a new and more illuftrious era in chemiftry. He was the author of the doctrine of phlogifton, which, though now completely overturned by the difcoveries of Lavoifier and others, was not without its ufe; as it ferved to combine the fcattered fragments of former chemifts into a fyftem, and as it gave rife to more accurate experiments and a more fcientific view of the fubject, to which many of the fubfequent difcoveries were owing. This theory maintained its ground for more than half a century, and was received and fupported by fome of the moft eminent men which Europe has produced; a fufficient proof of the ingenuity and the abilities of its author. He was the author alfo of A Theory of Medicine, founded upon the notions which he entertained of the abfolute dominion of mind over body; in confequence of which, he affirmed, that every mufcular action is a voluntary act of the mind, whether attended with confcioufnefs or not. This theory he and his followers carried a great deal too far, but the advices at leaft which he gives to attend to the ftate of the mind of the patient are worthy of the attention of phyficians.

His principal works are, 1. *Experimenta et Obfervationes Chemicæ et Phyficæ*, Berlin, 1731, 8vo. 2. *Differtationes Medicæ*, Hall, 2 vols 4to. This is a collection of thefes. 3. *Theoria Medica vera*, 1737, 4to. 4. *Opufculum Chymico-phyfico-medicum*, 1740, 4to. 5. A Treatife on Sulphur, both Inflammable and Fixed, written in German. 6. *Negotium Otiofum*, Hall, 1720, 4to. It is in this treatife chiefly that he eftablifhes his fyftem concerning the action of the foul upon the body. 7. *Fundamenta Chymicæ Dogmaticæ et Experimentalis*, Nuremberg, 1747, 3 vols 4to. 8. A treatife on Salts, written in German. 9. *Commentarium in Metallurgiam Beccheri*, 1723.

STAINING *or* Colouring *of* Bone, Horn, Marble, Paper, Wood, &c. See thefe articles.

STAIRCASE, in *Architecture*, an afcent inclofed between walls, or a baluftrade confifting of ftairs or fteps, with landing places and rails, ferving to make a communication between the feveral ftories of a houfe. See Architecture, N° 89, &c.

STALACTITES, in *Mineralogy*, cryftalline fpars formed into oblong, conical, round, or irregular bodies, compofed of various crufts, and ufually found hanging in form of ificles from the roofs of grottoes, &c.

STALAGMITIS, a genus of the monœcia order, belonging

belonging to the polygamia clafs of plants; and in the natural method ranking under the 38th order, *Tricoccæ*. See BOTANY and MATERIA MEDICA *Index*.

STALE, among fportfmen, a living fowl put in a place to allure and bring others where they may be taken. For want of thefe, a bird fhot, his entrails taken out, and dried in an oven in his feathers, with a ftick thruft through to keep it in a convenient pofture, may ferve as well as a live one.

STALE is alfo a name for the urine of cattle.

ANIMATED STALK. This remarkable animal was found by Mr Ives at Cuddalore: and he mentions feveral kinds of it; fome appearing like dry ftraws tied together, others like grafs; fome have bodies much larger than others, with the addition of two fcaly imperfect wings; their neck is no bigger than a pin, but twice as long as their bodies; their heads are like thofe of an hare, and their eyes vertical and very brifk. They live upon flies, and catch thefe infects very dexteroufly with the two fore-feet, which they keep doubled up in three parts clofe to their head, and dart out very quick on the approach of their prey; and when they have caught it, they eat it very voracioufly, holding it in the fame manner as a fquirrel does its food. On the outer joints of the fore-feet are feveral very fharp hooks for the eafier catching and holding of their prey; while, with the other feet, which are four in number, they take hold of trees or any other thing, the better to furprife whatever they lie in wait for. They drink like a horfe, putting their mouths into the water. Their excrements, which are very white, are almoft as large as the body of the animal, and as the natives fay, dangerous to the eyes.

STALLION, or STONE-HORSE, in the manege, a horfe defigned for the covering of mares, in order to propagate the fpecies. See EQUUS, MAMMALIA *Index*.

STAMFORD, an ancient town of Lincolnfhire in England; feated on the river Welland, on the edge of Northamptonfhire. It is a large handfome place, containing fix parifh-churches, feveral good ftreets, and fine buildings. It had formerly a college, the ftudents of which removed to Brazen Nofe college in Oxford. It has no confiderable manufactories, but deals chiefly in malt. W. Long. 0. 31. N. Lat. 54. 42.

STAMINA, in *Botany*, are thofe upright filaments which, on opening a flower, we find within the corolla furrounding the piftillum. According to Linnæus, they are the male organs of generation, whofe office it is to prepare the pollen. Each ftamen confifts of two diftinct parts, viz. the FILAMENTUM and the ANTHERA.

STAMINA, in the animal body, are defined to be thofe fimple original parts which exifted firft in the embryo or even in the feed; and by whofe diftinction, augmentation, and accretion by additional juices, the animal body at its utmoft bulk is fuppofed to be formed.

STAMP-DUTIES, a branch of the perpetual revenue. See REVENUE.

In Great Britain there is a tax impofed upon all parchment and paper, whereon any legal proceedings or private inftruments of almoft any nature whatfoever are written; and alfo upon licenfes for retailing wines, of all denominations; upon all almanacs, newfpapers, advertifements, cards, dice, &c. Thefe impofts are very various; being higher or lower, not fo much according to the value of the property transferred, as according to the nature of the deed. The higheft do not exceed fix pounds upon every fheet of paper or fkin of parchment; and thefe high duties fall chiefly upon grants from the crown, and upon certain law proceedings, without any regard to the value of the fubject. There are in Great Britain no duties on the regiftration of deeds or writings, except the fees of the officers who keep the regifter; and thefe are feldom more than a reafonable recompenfe for their labour. The crown derives no revenue from them.

Smith's Wealth of Nations, vol. iii.

The ftamp-duties conftitute a tax which, though in fome inftances it may be heavily felt, by greatly increafing the expence of all mercantile as well as legal proceedings, yet (if moderately impofed) is of fervice to the public in general, by authenticating inftruments, and rendering it much more difficult than formerly to forge deeds of any ftanding; fince, as the officers of this branch of the revenue vary their ftamps frequently, by marks perceptible to none but themfelves, a man that would forge a deed of King William's time, muft know and be able to counterfeit the ftamp of that date alfo. In France and fome other countries the duty is laid on the contract itfelf, not on the inftrument in which it is contained; as, with us too in England (befides the ftamps on the indentures), a tax is laid, by ftatute 8 Ann. c. 9. on every apprentice-fee; of 6d. in the pound if it be 50l. or under, and 1s, in the pound if a greater fum: but this tends to draw the fubject into a thoufand nice difquifitions and difputes concerning the nature of his contract, and whether taxable or not; in which the farmers of the revenue are fure to have the advantage. Our general method anfwers the purpofes of the ftate as well, and confults the eafe of the fubject much better. The firft inftitution of the ftamp-duties was by ftatute 5 and 6 W. and M. c 21. and they have fince, in many inftances, been increafed to five times their original amount.

STANCHION, or STANCHIONS, a fort of fmall pillars of wood or iron ufed for various purpofes in a fhip; as to fupport the decks, the quarter-rails, the nettings, the awnings, &c. The firft of thofe are two ranges of fmall columns fixed under the beams, throughout the fhip's length between decks; one range being on the ftarboard and the other on the larboard fide of the hatchways. They are chiefly intended to fupport the weight of the artillery.

STAND, in commerce, a weight from two hundred and an half to three hundred of pitch.

STANDARD, in *War*, a fort of banner or flag borne as a fignal for the joining together of the feveral troops belonging to the fame body.

STANDARD, in *Commerce*, the original of a weight, meafure, or coin, committed to the keeping of a magiftrate, or depofited in fome public place, to regulate, adjuft, and try the weights ufed by particular perfons in traffic. See MONEY.

STANHOPE PHILIP DORMER, EARL OF CHESTERFIELD, was born in 1695, and educated in Trinity-hall, Cambridge; which place he left in 1714, when, by his own account, he was an abfolute pedant. In this character he went abroad, where a familiarity with good company foon convinced him he was totally miftaken in almoft all his notions: and an attentive ftudy of the air, manner, and addrefs of people of fafhion, foon polifhed a man whofe predominant defire was to pleafe; and who, as it afterwards appeared, valued exterior accomplifh-

Stanhope. ments beyond any other human acquirement. While Lord Stanhope, he got an early feat in parliament; and in 1722, fucceeded to his father's eftate and titles. In 1728, and in 1745, he was appointed ambaffador extraordinary and plenipotentiary to Holland: which high character he fupported with the greateft dignity; ferving his own country, and gaining the efteem of the ftates-general. Upon his return from Holland, he was fent lord-lieutenant of Ireland; and during his adminiftration there, gave general fatisfaction to all parties. He left Dublin in 1746, and in October fucceeded the earl of Harrington as fecretary of ftate, in which poft he officiated until February 6th 1748. Being feized with a deafnefs in 1752 that incapacitated him for the pleafures of fociety, he from that time led a private and retired life, amufing himfelf with books and his pen; in particular, he engaged largely as a volunteer in a periodical mifcellaneous paper called *The World*, in which his contributions have a diftinguifhed degree of excellence. He died in 1773, leaving a character for wit and abilities that had few equals. He diftinguifhed himfelf by his eloquence in parliament on many important occafions; of which we have a characteriftic inftance, of his own relating. He was an active promoter of the bill for altering the ftyle; on which occafion, as he himfelf writes in one of his letters to his fon, he made fo eloquent a fpeech in the houfe, that every one was pleafed, and faid he had made the whole very clear to them; "when (fays he), God knows, I had not even attempted it. I could juft as foon have talked Celtic or Sclavonian to them, as aftronomy; and they would have underftood me full as well." Lord Macclesfield, one of the greateft mathematicians in Europe, and who had a principal hand in framing the bill, fpoke afterwards, with all the clearnefs that a thorough knowledge of the fubject could dictate; but not having a flow of words equal to Lord Chefterfield, the latter gained the applaufe from the former, to the equal credit of the fpeaker and the auditors. The high character Lord Chefterfield fupported during life, received no fmall injury foon after his death, from a fuller difplay of it by his own hand. He left no iffue by his lady, but had a natural fon, Philip Stanhope, Efq. whofe education was for many years a clofe object of his attention, and who was afterward envoy extraordinary at the court of Drefden, but died before him. When Lord Chefterfield died, Mr Stanhope's widow publifhed a courfe of letters, written by the father to the fon, filled with inftructions fuitable to the different gradations of the young man's life to whom they were addreffed. Thefe letters contain many fine obfervations on mankind, and rules of conduct: but it is obfervable that he lays a greater ftrefs on exterior accomplifhments and addrefs, than on intellectual qualifications and fincerity; and allows greater latitude to fafhionable pleafures than good morals will juftify, efpecially in paternal inftructions. Hence it is that a celebrated writer §, and of manners fomewhat different from thofe of the polite earl of Chefterfield, is faid to have obferved of thefe letters, that "they inculcate only the morals of a whore, with the manners of a dancing-mafter."

§ *Dr Johnfon.*

Stanhope, *Dr George*, an eminent divine, was born at Hertifhorn in Derbyfhire, in the year 1660. His father was rector of that place, vicar of St Margaret's church in Leicefter, and chaplain to the earls of Chefterfield and Clare. His grandfather, Dr George Stanhope, was chaplain to James I. and Charles I.; had the chancellorfhip of York, where he was alfo a canon-refidentiary, held a prebend, and was rector of Weldrake in that county. He was for his loyalty driven from his home with eleven children; and died in 1644. Our author was fent to fchool, firft at Uppingham in Rutland, then at Leicefter; afterwards removed to Eaton; and thence chofen to King's college in Cambridge, in the place of W. Cleaver. He took the degree of B. A. in 1681; M. A. 1685; was elected one of the fyndics for the univerfity of Cambridge, in the bufinefs of Alban Francis, 1687; minifter of Quoi near Cambridge, and vice-proctor, 1688; was that year preferred to the rectory of Tring in Hertfordfhire, which after fome time he quitted. He was in 1689 prefented to the vicarage of Lewifham in Kent by Lord Dartmouth, to whom he had been chaplain, and tutor to his fon. He was alfo appointed chaplain to King William and Queen Mary, and continued to enjoy that honour under Queen Anne. He commenced D. D. July 5th 1697, performing all the offices required to that degree publicly and with great applaufe. He was made vicar of Deptford in 1703; fucceeded Dr Hooper as dean of Canterbury the fame year; and was thrice chofen prolocutor of the lower houfe of convocation. His uncommon diligence and induftry, affifted by his excellent parts, enriched him with a large ftock of polite, folid, and ufeful learning. His difcourfes from the pulpit were equally pleafing and profitable; a beautiful intermixture of the cleareft reafoning with the pureft diction, attended with all the graces of a juft elocution. The good Chriftian, the folid divine, and the fine gentleman, in him were happily united. His converfation was polite and delicate, grave without precifenefs, facetious without levity. His piety was real and rational, his charity great and univerfal, fruitful in acts of mercy, and in all good works. He died March 18th 1728, aged 68 years; and was buried in the chancel of the church at Lewifham. The dean was twice married: firft to Olivia Cotton, by whom he had one fon and four daughters. His fecond lady, who was fifter to Sir Charles Wager, furvived him, dying October 1ft 1730, aged about 54. One of the dean's daughters was married to a fon of Bifhop Burnet. Bifhop Moore of Ely died the day before Queen Anne; who, it has been faid, defigned our dean for that fee when it fhould become vacant. Dr Felton fays, "The late dean of Canterbury is excellent in the whole. His thoughts and reafoning are bright and folid. His ftyle is juft, both for the purity of the language and for the ftrength and beauty of expreffion; but the periods are formed in fo peculiar an order of the words, that it was an obfervation, nobody could pronounce them with the fame grace and advantage as himfelf." His writings, which are an ineftimable treafure of piety and devotion are, A Paraphrafe and Comment upon the Epiftles and Gofpels, 4 vols, 1705, 8vo. Sermons at Boyle's Lectures, 1706, 4to. Fifteen Sermons, 1700, 8vo. Twelve Sermons on feveral Occafions, 1727, 8vo. Thomas à Kempis, 1696, 8vo. Epictetus's Morals, with Simplicius's Comment, and the Life of Epictetus, 1700, 8vo. Parfon's Chriftian Directory, 1716, 8vo. Rochefoucault's Maxims, 1706, 8vo. A Funeral Sermon on Mr Richard Sare bookfeller, 1724; two editions 4to. Twenty Sermons, publifhed fingly between

between the years 1692 and 1724. Private Prayers for every Day in the Week, and for the feveral Parts of each Day; tranflated from the Greek Devotions of Bifhop Andrews, with Additions, 1730. In his tranflations, it is well known, Dr Stanhope did not confine himfelf to a ftrict and literal verfion: he took the liberty of paraphrafing, explaining, and improving upon his author; as will evidently appear (not to mention any other work) by the flighteft perufal of St Auguftine's Meditations, and the Devotions of Bifhop Andrews.

STANISLAUS Leczinski, king of Poland, was born at Leopold the 20th of October 1677. His father was a Polifh nobleman, diftinguifhed by his rank and the important offices which he held, but ftill more by his firmnefs and courage. Staniflaus was fent ambaffador in 1704 by the affembly of Warfaw to Charles XII. of Sweden, who had conquered Poland. He was at that time 27 years old, was general of Great Poland, and had been ambaffador extraordinary to the Grand Signior in 1699. Charles was fo delighted with the franknefs and fincerity of his deportment, and with the firmnefs and fweetnefs which appeared in his countenance, that he offered him the crown of Poland, and ordered him to be crowned at Warfaw in 1705. He accompanied Charles XII. into Saxony, where a treaty was concluded with King Auguftus in 1705, by which that prince refigned the crown, and acknowledged Staniflaus king of Poland. The new monarch remained in Saxony with Charles till 1707, when they returned into Poland and attacked the Ruffians, who were obliged to evacuate that kingdom in 1708. But Charles being defeated by Peter the Great in 1709, Auguftus returned into Poland, and being affifted by a Ruffian army, obliged Staniflaus to retire firft into Sweden, and afterwards into Turkey. Soon after he took up his refidence at Weiffenburg, a town in Alface. Auguftus difpatched Sum his envoy to France to complain of this; but the duke of Orleans, who was then regent, returned this anfwer: "Tell your king, that France has always been the afylum of unhappy princes." Staniflaus lived in obfcurity till 1725, when Louis XV. efpoufed the princefs Mary his daughter. Upon the death of King Auguftus in 1733, he returned to Poland in hopes of remounting the throne of that kingdom. A large party declared for him; but his competitor the young elector of Saxony, being fupported by the emperor Charles VI. and the emprefs of Ruffia, was chofen king, though the majority was againft him. Dantzic, to which Staniflaus had retired, was quickly taken, and the unfortunate prince made his efcape in difguife with great difficulty, after hearing that a price was fet upon his head by the Ruffians. When peace was concluded in 1736 between the emperor and France, it was agreed that Staniflaus fhould abdicate the throne, but that he fhould be acknowledged king of Poland and grand duke of Lithuania, and continue to bear thefe titles during life; that all his effects and thofe of the queen his fpoufe fhould be reftored; that an amnefty fhould be declared in Poland for all that was paft, and that every perfon fhould be reftored to his poffeffions, rights, and privileges: that the elector of Saxony fhould be acknowledged king of Poland by all the powers who acceded to the treaty: that Staniflaus fhould be put in peaceable poffeffion of the duchies of Lorraine and Bar; but that immediately after his death thefe duchies fhould be united for ever to the crown of France. Staniflaus fucceeded a race of princes in Lorraine, who were beloved and regretted: and his fubjects found their ancient fovereigns revived in him. He tafted then the pleafure which he had fo long defired, the pleafure of making men happy. He affifted his new fubjects; he embellifhed Nancy and Luneville; he made ufeful eftablifhments; he founded colleges and built hofpitals. He was engaged in thefe noble employments, when an accident occafioned his death. His night-gown caught fire, and burnt him fo feverely before it could be extinguifhed, that he was feized with a fever, and died the 23d of February 1766. His death occafioned a public mourning: the tears of his fubjects indeed are the beft eulogium upon this prince. In his youth he had accuftomed himfelf to fatigue, and had thereby ftrengthened his mind as well as his conftitution. He lay always upon a kind of mattrefs, and feldom required any fervice from his domeftics. He was temperate, liberal, adored by his vaffals, and perhaps the only nobleman in Poland who had any friends. He was in Lorraine what he had been in his own country, gentle, affable, compaffionate, treating his fubjects like equals, participating their forrows and alleviating their misfortunes. He refembled completely the picture of a philofopher which he himfelf has drawn. "The true philofopher (faid he) ought to be free from prejudices, and to know the value of reafon: he ought neither to think the higher ranks of life of more value than they are, nor to treat the lower orders of mankind with greater contempt than they deferve: he ought to enjoy pleafures without being a flave to them, riches without being attached to them, honours without pride or vanity: he ought to fupport difgraces without either fearing or courting them: he ought to reckon what he poffeffes fufficient for him, and to regard what he has not as ufelefs: he ought to be eqoal in every fortune, always tranquil, always gay: he ought to love order, and to obferve it in all his actions: he ought to be fevere to himfelf, but indulgent to others: he ought to be frank and ingenuous without rudenefs, polite without falfehood, complaifant without bafenefs: he ought to have the courage to difregard every kind of glory, and to reckon as nothing even philofophy itfelf." Such was Staniflaus in every fituation. His temper was affectionate. He told his treafurer one day to put a certain officer on his lift, to whom he was very much attached: "In what quality (faid the treafurer) fhall I mark him down?" "As my friend" (replied the monarch). A young painter conceiving hopes of making his fortune if his talents were made known to Staniflaus, prefented him with a picture, which the courtiers criticifed feverely. The prince praifed the performance, and paid the painter very generoufly: then turning to his courtiers, he faid, "Do ye not fee, gentlemen, that this poor man muft provide for his family by his abilities? if you difcourage him by your cenfures, he is undone. We ought always to affift men; we never gain any thing by hurting them." His revenues were fmall; but were we to judge of him by what he did, we fhould probably reckon him the richeft potentate in Europe. A fingle inftance will be fufficient to fhow the well-judged economy with which his benevolent plans were conducted. He gave 18,000 crowns to the magiftrates of Bar to be employed in purchafing grain, when at a low price, to be fold out again to the poor at a moderate rate when the

the price should rise above a certain sum. By this arrangement (say the authors of *Dictionaire Historique*), the money increases continually, and its good effects may in a short time be extended over the whole province.

He was a protector of the arts and sciences: he wrote several works of philosophy, politics, and morality, which were collected and published in France in 1765, in 4 vols, 8vo, under the title of *Oeuvres de Philosophe Bienfaisant*, "the works of the Benevolent Philosopher."

STANITZAS, villages or small districts of the banks of the Don, inhabited by Cossacs.

STANLEY, Thomas, a learned English writer in the 17th century, was the son of Sir Thomas Stanley of Cumberlow-Green in Herefordshire, knight. He was born at Cumberlow about 1644, and educated in his father's house, whence he removed to the university of Cambridge. He afterwards travelled; and, upon his return to England, prosecuted his studies in the Middle Temple. He married, when young, Dorothy, the eldest daughter of Sir James Engan of Flower, in Northamptonshire. He wrote, 1. A volume of Poems. 2. History of Philosophy, and Lives of the Philosophers. 3. A Translation of Eschylus, with a Commentary; and several other works. He died in 1678.

STANNARIES, the mines and works where tin is dug and purified; as in Cornwall, Devonshire, &c.

STANNARY courts, in Devonshire and Cornwall, for the administration of justice among the tinners therein. They are held before the lord-warden and his substitutes, in virtue of a privilege granted to the workers in the tin-mines there, to sue and be sued only in their own courts, that they may not be drawn from their business, which is highly profitable to the public, by attending their law-suits in other courts. The privileges of the tinners are confirmed by a charter, 33 Edw. I. and fully expounded by a private statute, 50 Edw. III. which has since been explained by a public act. 16 Car. I. c. 15. What relates to our present purpose is only this: That all tinners and labourers in and about the stannaries shall, during the time of their working therein, *bona fide*, be privileged from suits of other courts, and be only pleaded in the stannary court in all matters, excepting pleas of land, life, and member. No writ of error lies from hence to any court in Westminster-hall; as was agreed by all the judges, in 4 Jac. I. But an appeal lies from the steward of the court to the underwarden; and from him to the lord-warden; and thence to the privy-council of the prince of Wales, as duke of Cornwall, when he hath had livery or investiture of the same. And from thence the appeal lies to the king himself, in the last resort.

Blackstone's Comment. vol. iii. p. 79 and 80.

STANNUM, Tin. See Tin, Chemistry and Mineralogy *Index*.

STANZA, in *Poetry*, a number of lines regularly adjusted to each other; so much of a poem as contains every variation of measure or relation of rhyme used in that poem.

STAPELIA, a genus of plants belonging to the class pentandria and order digynia, and in the natural orders arranged under the *Succulentæ*. See Botany *Index*.—This singular tribe of plants is peculiar to the sandy deserts of Africa and Arabia. They are extremely succulent. From this peculiarity of structure, the power of retaining water to support and nourish them, they are enabled to live during the prevalent droughts of those arid regions. On this account the stapelia has been compared to the camel; and we are told that, by a very apt similitude, it has been denominated "the *camel* of the vegetable kingdom." We must confess ourselves quite at a loss to see the propriety or aptitude of this comparison. In many parts of the animal and vegetable economy there is doubtless a very obvious and striking analogy: but this analogy has been often carried too far; much farther than fair experiment and accurate observation will in any degree support. It is perhaps owing to this inaccuracy in observing the peculiarity of structure and diversity of functions, that a resemblance is supposed to exist, as in the present case, where in reality there is none. The camel is provided with a bag or fifth stomach, in addition to the four with which ruminant animals are furnished. This fifth stomach is destined as a reservoir to contain water; and it is sufficiently capacious to receive a quantity of that necessary fluid, equal to the wants of the animal, for many days: and this water, as long as it remains in the fifth stomach, is said to be perfectly pure and unchanged. The *stapelia*, and other succulent plants, have no such reservoir. The water is equally, or nearly so, diffused through the whole plant. Every vessel and every cell is fully distended. But besides, this water, whether it be received by the roots, or absorbed from the atmosphere, has probably undergone a complete change, and become, after it has been a short time within the plant, a fluid possessed of very different qualities.

The peculiar economy in the stapelia, and other succulent plants, seems to exist in the absorbent and exhalant systems. The power of absorption is as much increased as the power of the exhalant or perspiratory vessels is diminished. In these plants, a small quantity of nourishment is required. There is no solid part to be formed, no large fruit to be produced. They generally have very small leaves, often are entirely naked; so that taking the whole plant, a small surface only is exposed to the action of light and heat, and consequently a much smaller proportion of water is decomposed than in plants which are much branched and furnished with leaves.

Two species of stapelia only were known at the beginning of the century. The unfortunate Forskal, the companion of Niebhur, who was sent out by the king of Denmark to explore the interior of Arabia, and who fell a sacrifice to the pestilential diseases of those inhospitable regions, discovered two new species. Thunberg, in his *Prodromus*, has mentioned five more. Forty new species have been discovered by Mr Masson of Kew Gardens, who was sent out by his present Majesty for the purpose of collecting plants round the Cape of Good Hope. Descriptions of these, with elegant and highly finished coloured engravings, have lately been published. They are chiefly natives of the extensive deserts called *Karro*, on the western side of the Cape.

STAPHYLEA, Bladder-nut, a genus of plants belonging to the class of pentandria and order of trigynia; and in the natural system arranged under the 23d order, *Trihilatæ*. See Botany *Index*.

STAPHYLINUS, a genus of insects belonging to the order of coleoptera. See Entomology *Index*.

STAPLE, primarily signifies a public place or market, whither merchants, &c. are obliged to bring their goods to be bought by the people; as the Greve, or the places along the Seine, for sale of wines and corn, at Paris, whither the merchants of other parts are obliged to bring those commodities.

Formerly, the merchants of England were obliged to carry their wool, cloth, lead, and other like staple commodities of this realm, in order to expose them by wholesale; and these staples were appointed to be constantly kept at York, Lincoln, Newcastle-upon-Tyne, Norwich, Westminster, Canterbury, Chichester, Winchester, Exeter, and Bristol; in each whereof a public mart was appointed to be kept, and each of them had a court of the mayor of the staple, for deciding differences, held according to the law-merchant, in a summary way.

STAR, in *Astronomy*, a general name for all the heavenly bodies, which, like so many brilliant studs, are dispersed throughout the whole heavens. The stars are distinguished, from the phenomena of their motion, &c. into fixed, and erratic or wandering stars: these last are again distinguished into the greater luminaries, viz. the sun and moon; the planets, or wandering stars, properly so called, and the comets; which have been all fully considered and explained under the article ASTRONOMY. As to the fixed stars, they are so called, because they seem to be fixed, or perfectly at rest, and consequently appear always at the same distance from each other.

Falling STARS, in *Meteorology*, fiery meteors which dart through the sky in form of a star. See METEOR.

Twinkling of the STARS. See OPTICS.

STAR, is also a badge of honour, worn by the knights of the garter, bath, and thistle. See GARTER.

STAR of Bethlehem. See ORNITHOGALUM, BOTANY *Index*

STAR, in *Fortification*, denotes a small fort, having five or more points, or saliant and re-entering angles, flanking one another, and their faces 90 or 100 feet long.

Court of STAR-CHAMBER, (camera stellata), a famous, or rather infamous, English tribunal, said to have been so called either from a Saxon word signifying to *steer* or govern; or from its punishing the *crimen stellionatus*, or cosenage; or because the room wherein it sat, the old council-chamber of the palace of Westminster, (Lamb. 148.) which is now converted into the lottery-office, and forms the eastern side of New-Palace yard, was full of windows; or, (to which Sir Edward Coke, 4 Inst. 66. accedes), because *haply* the roof thereof was at the first garnished with gilded *stars*. As all these are merely conjectures, (for no stars are now in the roof, nor are any said to have remained there so late as the reign of Queen Elizabeth), it may be allowable to propose another conjectural etymology, as plausible perhaps as any of them. It is well known, that, before the banishment of the Jews under Edward I. their contracts and obligations were denominated in our ancient records *starra* or *starrs*, from a corruption of the Hebrew word, *shetar*, a covenant. (Tovey's *Angl. Judaic.* 32. Selden. tit. of hon. ii. 34. *Uxor Ebraic.* i. 14.). These starrs, by an ordinance of Richard I. preserved by Hoveden, were commanded to be enrolled and deposited in chests

Blackstone's Comment. vol. iv. p. 266.

under three keys in certain places; one, and the most considerable, of which was in the king's exchequer at Westminster: and no starr was allowed to be valid, unless it were found in some of the said repositories. (*Memorand. in Scac' P. 6. Edw. I.* prefixed to Maynard's year-book of Edw. II. fol. 8. Madox hist. exch. c. vii. § 4, 5, 6.). The room at the exchequer, where the chests containing these starrs were kept, was probably called the *star-chamber*; and, when the Jews were expelled the kingdom, was applied to the use of the king's council, sitting in their judicial capacity. To confirm this, the first time the star-chamber is mentioned in any record, it is said to have been situated near the receipt of the exchequer at Westminster: (the king's council, his chancellor, treasurer, justices, and other sages, were assembled *en la chaumbre des esteilles pres la resceipt at Westminster. Claus.* 41 *Edw. III. m.* 13.). For in process of time, when the meaning of the Jewish *starrs* were forgotten, the word *star-chamber* was naturally rendered in law French, *la chaumbre des esteilles*, and in law Latin *camera stellata*; which continued to be the style in Latin till the dissolution of that court.

This was a court of very ancient original; but new-modelled by statutes 3 Hen. VII. c. 1. and 21 Henry VIII. c. 20. consisting of divers lords spiritual and temporal, being privy-counsellors, together with two judges of the courts of common law, without the intervention of any jury. Their jurisdiction extended legally over riots, perjury, misbehaviour of sheriffs, and other notorious misdemeanors, contrary to the laws of the land. Yet this was afterwards (as Lord Clarendon informs us) stretched "to the asserting of all proclamations and orders of state; to the vindicating of illegal commissions and grants of monopolies; holding for honourable that which pleased, and for just that which profited; and becoming both a court of law to determine civil rights, and a court of revenue to enrich the treasury: the council-table by proclamations enjoining to the people that which was not enjoined by the laws, and prohibiting that which was not prohibited; and the star-chamber, which consisted of the same persons in different rooms, censuring the breach and disobedience to those proclamations by very great fines, imprisonments, and corporal severities: so that any disrespect to any acts of state, or to the persons of statesmen, was in no time more penal, and the foundations of right never more in danger to be destroyed." For which reasons, it was finally abolished by statute 16 Car. I. c. 10. to the general joy of the whole nation. See *KING's-Bench.* There is in the British Museum (Harl. MSS. vol. i. N° 126.) a very full, methodical, and accurate account of the constitution and course of this court, compiled by William Hudson of Gray's Inn, an eminent practitioner therein. A short account of the same, with copies of all its process, may also be found in 18 Rym. Foed. 192, &c.

STAR-Board, the right side of the ship when the eye of the spectator is directed forward.

STAR-Fish. See ASTERIAS, HELMINTHOLOGY *Index*.

STAR-Shot, a gelatinous substance frequently found in fields, and supposed by the vulgar to have been produced from the meteor called a *falling-star*: but, in reality, is the half-digested food of herons, sea-mews, and

and the like birds; for thefe birds have been found when newly fhot, to difgorge a fubftance of the fame kind.

STAR-Stone, in *Natural Hiftory*, a name given to certain extraneous foffil ftones, in form of fhort, and commonly fomewhat crooked columns, compofed of feveral joints, each refembling the figure of a radiated ftar, with a greater or fmaller number of rays in the different fpecies: they are ufually found of about an inch in length, and of the thicknefs of a goofe-quill. Some of them have five angles or rays, and others only four; and in fome the angles are equidiftant, while in others they are irregularly fo: in fome alfo they are fhort and blunt, while in others they are long, narrow, and pointed; and fome have their angles very fhort and obtufe. The feveral joints in the fame fpecimen are ufually all of the fame thicknefs; this, however, is not always the cafe: but in fome they are larger at one end, and in others at the middle, than in any other part of the body; and fome fpecies have one of the rays bifid, fo as to emulate the appearance of a fix-rayed kind.

STAR-Thiftle. See CENTAUREA, } BOTANY *Index*.
STAR-Wort. See ASTER, } BOTANY *Index*.

STARCH, a fecula or fediment, found at the bottom of veffels wherein wheat has been fteeped in water, of which fecula, after feparating the bran from it, by paffing it through fieves, they form a kind of loaves, which being dried in the fun or an oven, is afterwards cut into little pieces, and fo fold. The beft ftarch is white, foft, and friable, and eafily broken into powder. Such as require fine ftarch, do not content themfelves, like the ftarchmen, with refufe wheat, but ufe the fineft grain. The procefs is as follows: The grain, being well cleaned, is put to ferment in veffels full of water, which they expofe to the fun while in its greateft heat; changing the water twice a-day, for the fpace of eight or twelve days, according to the feafon. When the grain burfts eafily under the finger, they judge it fufficiently fermented. The fermentation perfected, and the grain thus foftened, it is put, handful by handful, into a canvas-bag, to feparate the flour from the hufks; which is done by rubbing and beating it on a plank laid acrofs the mouth of an empty veffel that is to receive the flour.

As the veffels are filled with this liquid flour, there is feen fwimming at top a reddifh water, which is to be carefully fcummed off from time to time, and clean water is to be put in its place, which, after ftirring the whole together, is alfo to be ftrained through a cloth or fieve, and what is left behind put into the veffel with new water, and expofed to the fun for fome time. As the fediment thickens at the bottom, they drain off the water four or five times, by inclining the veffel, but without paffing it through the fieve. What remains at bottom is the ftarch, which is cut in pieces to get out, and left to dry in the fun. When dry, it is laid up for ufe.

The following mill, was invented by M. Baumé for grinding potatoes, with a view to extract ftarch from them.

He had a grater made of plate iron, in a cylindrical form (fig. 1.) about feven inches in diameter, and about eight inches high; the burs made by ftumping the holes are on the infide. This grater is fupported upon three feet AAA, made of flat iron bars, feven feet high,

Plate D. Fig. 1.

ftrongly rivetted to the grater; the bottom of each foot is bent horizontally, and has a hole in it which receives a fcrew, as at A, fig. 4. A little below the upper end of the three feet is fixed a crofs piece B (fig. 1. and 4.), divided into three branches, and rivetted to the feet. This crofs piece not only ferves to keep the feet at a pruper diftance from each other, and to prevent their bending; but the centre of it having a hole cut in it, ferves to fupport an axis or fpindle of iron, to be prefently defcribed.

The upper end of this cylindrical grater has a diverging border of iron C (fig. 1. 4. and 7.), about 10 inches in diameter at the top, and five inches in height.

Within this cylindrical grater is placed a fecond grater (fig. 2. and 3.), in the form of a cone, the point of which is cut off. The latter is made of thick plate iron, and the burs of the holes are on the outfide; it is fixed, with the broad end at the bottom, as in fig. 4. At the upper end of the cone is rivetted a fmall triangle, or crofs piece of iron, confifting of three branches D (fig. 2.), in the middle of which is made a fquare hole, to receive an axis or fpindle; to give more refiftance to this part of the cone, it is ftrengthened by means of a cap of iron E, which is fixed to the grater by means of rivets, and has alfo a fquare hole made in it, to let the axis pafs through.

Fig. 3. reprefents the fame cone feen in front; the bafe F has alfo a crofs piece of three branches, rivetted to a hoop of iron, which is fixed to the inner furface of the cone; the centre of this crofs piece has alfo a fquare hole for the paffage of the axis.

Fig. 5. is a fpindle or axis itfelf; it is a fquare bar of iron about 16 inches long, and more than half an inch thick; round at the bottom, and alfo towards the top, where it fits into the crofs piece I, fig. 7. and B, fig. 1. and 4.; in thefe pieces it turns round, and by them it is kept in its place. It muft be fquare at its upper extremity, that it may have a handle, about nine inches long, fixed to it, by means of which the conical grater is turned round. At G, (fig. 5.), a fmall hole is made through the axis, to receive a pin H, by means of which the conical grater is kept at its proper height within the cylindrical one.

Fig. 6. is a bird's-eye view, in which the mill is reprefented placed in an oval tub, like a bathing-tub. I is the fore-mentioned triangular iron crofs, fixed with fcrews to the fide of the tub; the centre of it has a round hole, for the axis of the mill to move in when it is ufed.

Fig. 7. reprefents the mill in the oval tub; it is placed at one end of it, that the other end may be left free for any operation to be performed in it which may be neceffary. A part of the tub is cut off, that the infide of it, and the manner of fixing the mill, may be feen. That the bottom of the tub may not be worn by the fcrews which pafs through the feet of the mill, a deal board, about an inch thick, and properly fhaped, is placed under the mill.

When we wifh to make ufe of this mill, it is to be fixed by the feet, in the manner already defcribed; it is alfo fixed at the top, by means of the crofs piece I, fig. 6. and 7. The tub is then to have water poured into it as high as K, and the top of the mill is to be filled with potatoes, properly wafhed and cut; the handle L is to be turned round, and the potatoes, after being ground

between

between the two graters, go out gradually at the lower part, being affifted by the motion produced in the water by the action of the mill.

To prepare ftarch from potatoes, fays M. Baumé, any quantity of thefe roots may be taken, and foaked in a tub of water for about an hour; they are afterwards to have their fibres and fhoots taken off, and then to be rubbed with a pretty ftrong brufh, that the earth, which is apt to lodge in the inequalities of their furface, may be entirely removed; as this is done, they are to be wafhed, and thrown into another tub full of clean water. When the quantity which we mean to make ufe of has been thus treated, thofe which are too large are to be cut into pieces about the fize of eggs, and thrown into the mill; that being already fixed in the oval tub, with the proper quantity of water: the handle is then turned round, and as the potatoes are grated they pafs out at the bottom of the mill. The pulp which collects about the mill muft be taken off from time to time with a wooden fpoon, and put afide in water.

When all the potatoes are ground, the whole of the pulp is to be collected in a tub, and mixed up with a great quantity of clean water. At the fame time, another tub, very clean, is to be prepared, on the brim of which are to be placed two wooden rails, to fupport a hair fieve, which muft not be too fine. The pulp and water are to be thrown into the fieve; the flour paffes through with the water, and frefh quantities of water are fucceffively to be poured on the remaining pulp, till the water runs through as clear as it is poured in. In this way we are to proceed till all the potatoes that were ground are ufed.

The pulp is commonly thrown away as ufelefs; but it fhould be boiled in water, and ufed as food for animals; for it is very nourifhing, and is about $\frac{4}{5}$ths of the whole quantity of potatoes ufed.

It is farther to be obferved that the liquor which has paffed through the fieve is turbid, and of a brownifh colour, on account of the extractive matter which is diffolved in it; it depofits, in the fpace of five or fix hours, the flour which was fufpended in it. When all the flour is fettled to the bottom, the liquor is to be poured off and thrown away, being ufelefs; a great quantity of very clean water is then to be poured upon the flour remaining at the bottom of the tub, which is to be ftirred up in the water, that it may be wafhed, and the whole is to ftand quiet till the day following. The flour will then be found to have fettled at the bottom of the tub; the water is again to be poured off as ufelefs, the flour wafhed in a frefh quantity of pure water, and the mixture paffed through a filk fieve pretty fine, which will retain any fmall quantity of pulp which may have paffed through the hair fieve. The whole muft once more be fuffered to ftand quiet till the flour is entirely fettled; if the water above it is perfectly clear and colourlefs, the flour has been fufficiently wafhed; but if the water has any fenfible appearances either of colour or of tafte, the flour muft be again wafhed, as it is abfolutely neceffary that none of the extractive matter be fuffered to remain.

When the flour is fufficiently wafhed, it may be taken out of the tub with a wooden fpoon; it is to be placed upon wicker frames covered with paper, and dried, properly defended from duft. When it is thoroughly dry, it is to be paffed through a filk fieve, that if any clotted lumps fhould have been formed they may be divided. It is to be kept in glafs-veffels ftopped with paper only.

A patent was granted in 1796 to Lord William Murray for his difcovery of a method by which ftarch may be extracted from horfe-chefnuts. It is as follows:

Take the horfe-chefnuts out of the outward green prickly hufks; and either by hand, with a knife, or other tool, or elfe with a mill adapted for that purpofe, very carefully pare off the brown rind, being particular not to leave the fmalleft fpeck, and to entirely eradicate the fprout or growth. Next take the nuts, and rafp, grate, or grind them fine into water, either by hand, or by a mill adapted for that purpofe. Wafh the pulp, which is thereby formed in this water, as clean as poffible, through a coarfe horfe-hair fieve; this again wafh through a finer fieve, and then again through a ftill finer, conftantly adding clean water, to prevent any ftarch from adhering to the pulp. The laft procefs is, to put it with a large quantity of water (about four gallons to a pound of ftarch) through a fine gauze, muflin, or lawn, fo as entirely to clear it of all bran or other impurities. As foon as it fettles, pour off the water; then mix it up with clean water, repeating this operation till it no longer imparts any green, yellow, or other colour to the water. Then drain it off till nearly dry, and fet it to bake, either in the ufual mode of baking ftarch, or elfe fpread out before a brifk fire; being very attentive to ftir it frequently to prevent its horning, that is to fay, turning to a pafte or jelly, which, on being dried, turns hard like horn. The whole procefs fhould be conducted as quickly as poffible.

Mention is here made of a mill which may be employed to grind the horfe-chefnuts; but it is not defcribed; perhaps the one defcribed above for grinding potatoes might anfwer the purpofe.

STARK, Dr William, known to the public by a volume containing Clinical and Anatomical Obfervations, with fome curious Experiments on Diet, was born at Manchefter in the month of July 1740; but the family from which he fprang was Scotch, and refpectable for its antiquity. His grandfather John Stark of Killermont was a covenanter; and having appeared in arms againft his fovereign at the battle of Bothwel bridge in the year 1679, became obnoxious to the government, and, to conceal himfelf, withdrew into Ireland. There is reafon to believe that he had not imbibed either the extravagant zeal or the favage manners of the political and religious party to which he adhered; for after refiding a few years in the country which he had chofen for the fcene of his banifhment, he married Elizabeth daughter of Thomas Stewart, Efq. of Balydrone in the north of Ireland; who, being defcended of the noble family of Galloway, would not probably have matched his daughter to fuch an exile as a ruthlefs fanatic of the laft century. By this lady Mr Stark had feveral children; and his fecond fon Thomas, who fettled at Manchefter as a wholefale linen-draper, and married Margaret Stirling, daughter of William Stirling, Efq. of Northwoodfide, in the neighbourhood of Glafgow, was the father of the fubject of this article. Another of his fons, the reverend John Stark, was minifter of Lecropt in Perthfhire; and it was under the care of this gentleman that our author received the rudiments of his education, which, when we confider the character of the mafter, Stark.

and reflect on the relation between him and his pupil, we may presume was calculated to store the mind of Dr Stark with those virtuous principles which influenced his conduct through life.

From Lecropt young Stark was sent to the university of Glasgow, where, under the tuition of the doctors Smith and Black, with other eminent masters, he learned the rudiments of science, and acquired that mathematical accuracy, that logical precision, and that contempt of hypotheses, with which he prosecuted all his future studies. Having chosen physic for his profession. he removed from the university of Glasgow to that of Edinburgh, where he was soon distinguished, and honoured with the friendship of the late Dr Cullen; a man who was not more eminently conspicuous for the superiority of his own genius, than quick-sighted in perceiving, and liberal in encouraging, genius in his pupils. Having finished his studies at Edinburgh, though he took there no degree, Mr Stark, in the year 1765, went to London, and devoted himself entirely to the study of physic and the elements of surgery; and looking upon anatomy as one of the principal pillars of both these arts, he endeavoured to complete with Dr Hunter what he had begun with Dr Monro; and under these two eminent professors he appears to have acquired a high degree of anatomical knowledge. He likewise entered himself about this time a pupil at St George's hospital; for being disgusted, as he often confessed, with the inaccuracy or want of candour observable in the generality of practical writers, he determined to obtain an acquaintance with diseases at a better school and from an abler master; and to have from his own experience a standard, by which he might judge of the experience of others. With what industry he prosecuted this plan, and with what success his labours were crowned, may be seen in a series of Clinical and Anatomical Observations, which were made by him during his attendance at the hospital, and were published after his death by his friend Dr Carmichael Smyth. These observations give the public no cause to complain of want of candour in their author; for whatever delicacy he may have observed, when relating the cases of patients treated by other physicians, he has related those treated by himself with the utmost impartiality. Whilst attending the hospital, he likewise employed himself in making experiments on the blood, and other animal fluids; and also in a course of experiments in chemical pharmacy; but though accounts of these experiments were left behind him, we believe they have not yet been given to the public.

In the year 1767 Mr Stark went abroad, and obtained the degree of M. D in the university of Leyden, publishing an inaugural dissertation on the dysentery. On his return to London, he recommenced his studies at the hospital; and when Dr Black was called to the chemical chair in Edinburgh, which he has long filled with so much honour to himself and credit to the university, Dr Stark was solicited by several members of the university of Glasgow to stand a candidate for their professorship of the theory and practice of physic, rendered vacant by Dr Black's removal to Edinburgh. This however Dr Stark declined, being influenced by the advice of his English friends, who wished to detain him in London, and having likewise some prospects of an appointment in the hospital.

In the mean time he had commenced (1769) a series of experiments on diet, which he was encouraged to undertake by Sir John Pringle and Dr Franklin, whose friendship he enjoyed, and from whom he received many hints respecting both the plan and its execution. These experiments, or rather the imprudent zeal with which he prosecuted them, proved, in the opinion of his friends, fatal to himself; for he began them on the 12th of July 1769 in perfect health and vigour, and from that day, though his health varied, it was seldom if ever good, till the 23d of February 1770, when he died, after suffering much uneasiness. His friend and biographer Dr Smyth thinks, that other causes, particularly chagrin and disappointment, had no small share in hastening his death; and as the Doctor was intimately acquainted with his character and disposition, his opinion is probably well-founded, though the pernicious effects of the experiments are visible in Dr Stark's own journal. When he entered upon them, the weight of his body was 12 stone 3 lb. avoirdupois, which in a very few days was reduced to 11 stone 10 lb. 8 oz.: and though some kinds of food increased it, by much the greater part of what he used had a contrary effect, and it continued on the whole to decrease till the day of his death. This indeed can excite no wonder. Though the professed object of his experiments was to prove that a *pleasant* and varied diet is equally conducive to health with a more strict and simple one, most of the dishes which he ate during these experiments were neither pleasant nor simple, but compounds, such as every stomach must nauseate. He began with *bread* and *water;* from which he proceeded to *bread*, *water*, and *sugar;* then to *bread*, *water*, and *oil of olives;* then to *bread* and *water* with *milk;* afterwards he tried *bread* and *water* with *roasted goose; bread* and *water* with *boiled beef; stewed lean of beef* with the *gravy* and *water* without bread; *stewed lean of beef* with the *gravy*, *oil* of *fat* or *suet* and *water; flour*, *oil of suet*, *water* and *salt; flour*, *water*, and *salt;* and a number of others infinitely more disagreeable to the stomach than even these, such as *bread, fat of bacon ham*, *infusion of tea* with *sugar;* and *bread* or *flour* with *honey* and the infusion of *rosemary*. But though we consider Dr Stark's experiments as whimsical, it cannot be denied that they indicate eccentricity of genius in the person who made them; and such of our readers as think genius hereditary, may perhaps be of opinion, that he derived a ray from the celebrated NAPIER the inventor of the logarithms, who was his ancestor by both parents. At any rate, these experiments, of which a full account is given in the same volume with his clinical and anatomical observations, display an uncommon degree of fortitude, perseverance, self-denial, and zeal for the promoting of useful knowledge in their author; and with respect to his moral character, we believe it is with great justice that Dr Smyth compares him to Cato, by applying to him what was said of that virtuous Roman by Sallust—" Non divitiis cum divite, neque factione cum factioso; sed cum strenuo virtute, cum modesto pudore, cum innocente abstinentia certabat; esse, quam videri, bonus malebat * "

* *Bellum Catilinarium.*

Stark || Starlings.

STARLING. See STURNUS, ORNITHOLOGY *Index*.

STARLINGS, or STERLINGS, the name given to the strong pieces of timber which were driven into the bed of the river to protect the piles, on the top of which were laid the flat beams upon which were built the

the bases of the stone piers that support the arches of London bridge. In general, starlings are large piles placed on the outside of the foundation of the piers of bridges, to break the force of the water, and to protect the stone work from injury by floating ice. They are otherwise called *jetts*, and their place is often supplied by large stones thrown at random round the piers of bridges, as may be seen at Stirling bridge when the river is low; and as was done by Mr Smeaton's direction round the piers of the centre arch of London bridge, when it was thought in danger of being undermined by the current.

STATE OF A CONTROVERSY. See ORATORY, Part I. N° 14.

STATES, or ESTATES, a term applied to several orders or classes of people assembled to consult of matters for the public good.

Thus states-generals, in the old government of Holland, is the name of an assembly consisting of the deputies of the seven United Provinces. These were usually 30 in number, some provinces sending two, others more; and whatever resolution the states-general took was confirmed by every province, and by every city and republic in that province, before it had the force of a law. The deputies of each province, of what number soever they were, had only one voice, and were esteemed as but one person, the votes being given by provinces. Each province presided in the assembly in its turn, according to the order settled among them. Guelderland presided first, then Holland, &c.

States of Holland were the deputies of eighteen cities, and one representative of the nobility, constituting the states of the province of Holland: the other provinces had likewise their states, representing their sovereignty; deputies from which made what was called the states-general. In an assembly of the states of a particular province, one dissenting voice prevented their coming to any resolution.

STATICE, THRIFT, a genus of plants belonging to the class of pentandria, and order of pentagynia; and in the natural system ranging under the 48th order, *Aggregatae*. See BOTANY *Index*.

STATICS, a term which the modern improvements in knowledge have made it necessary to introduce into physico-mathematical science. It was found convenient to distribute the doctrines of universal mechanics into two classes, which required both a different mode of consideration and different principles of reasoning.

Till the time of Archimedes little science of this kind was possessed by the ancients, from whom we have received the first rudiments. His investigation of the centre of gravity, and his theory of the lever, are the foundations of our knowledge of common mechanics; and his theory of the equilibrium of floating bodies contains the greatest part of our hydrostatical knowledge. But it was as yet limited to the simplest cases; and there were some in which Archimedes was ignorant, or was mistaken. The marquis Guido Ubuldi, in 1578, published his theory of mechanics, in which the doctrines of Archimedes were well explained and considerably augmented. Stevinus, the celebrated Dutch engineer, published about 20 years after an excellent system of mechanics, containing the chief principles which now form the science of equilibrium among solid bodies. In particular, he gave the theory of inclined planes, which was unknown to the ancients, though it is of the very first importance in almost every machine. He even states in the most express terms the principle afterwards made the foundation of the whole of mechanics, and published as a valuable discovery by Varignon, viz. that three forces, whose directions and intensities are as the sides of a triangle, balance each other. His theory of the pressure of fluids, or hydrostatics, is no less estimable, including every thing that is now received as a leading principle in the science. When we consider the ignorance, even of the most learned, of that age, in mechanical or physico-mathematical knowledge, we must consider these performances as the works of a great genius; and we regret that they are so little known, being lost in a crowd of good writings on those subjects which appeared soon after.

Hitherto the attention had been turned entirely to equilibrium, and the circumstances necessary for producing it. Mechanicians indeed saw, that the energy of a machine might be somehow measured by the force which could be opposed or overcome by its intervention: but they did not remark, that the force which prevented its motion, but did no more than prevent it, was an *exact* measure of its energy, because it was in immediate equilibrio with the pressure exerted by that part of the machine with which it was connected. If this opposed force was less, or the force acting at the other extremity of the machine was greater, the mechanicians knew that the machine would move, and that work would be performed; but what would be the rate of its motion or its performance, they hardly pretended to conjecture. They had not studied the action of moving forces, nor conceived what was done when motion was communicated.

The great Galileo opened a new field of speculation in his work on Local Motion. He there considers a change of motion as the indication and exact and adequate measure of a moving force; and he considers every kind of pressure as competent to the production of such changes.—He contented himself with the application of this principle to the motion of bodies by the action of gravity, and gave the theory of projectiles, which remains to this day without change, and only improved by considering the changes which are produced in it by the resistance of the air.

Sir Isaac Newton took up this subject nearly as Galileo had left it. For, if we except the theory of the centrifugal forces arising from rotation, and the theory of pendulums, published by Huygens, hardly any thing had been added to the science of motion. Newton considered the subject in its utmost extent; and in his mathematical principles of natural philosophy he considers every conceivable variation of moving force, and determines the motion resulting from its action.—His first application of these doctrines was to explain the celestial motions; and the magnificence of this subject caused it to occupy for a while the whole attention of the mathematicians. But the same work contained propositions equally conducive to the improvement of common mechanics, and to the complete understanding of the mechanical actions of bodies. Philosophers began to make these applications also. They saw that every kind of work which is to be performed by a machine may be considered abstractedly as a retarding force; that the impulse of water or wind, which are employed as moving powers, Statics ‖ Statistics.

act by means of pressures which they exert on the impelled point of the machine; and that the machine itself may be considered as an assemblage of bodies moveable in certain limited circumstances, with determined directions and proportions of velocity. From all these considerations resulted a general abstract condition of a body acted on by known powers. And they found, that after all conditions of equilibrium were satisfied, there remains a surplus of moving force. They could now state the motion which will ensue, the new resistance which this will excite, the additional power which this will absorb; and they at last determined a new kind of equilibrium, not thought of by the ancient mechanicians, between the resistance to the machine performing work and the moving power, which exactly balance each other, and is indicated, not by the *rest*, but by the *uniform motion* of the machine.—In like manner, the mathematician was enabled to calculate that precise motion of water which would completely absorb, or, in the new language, balance the superiority of pressure by which water is forced through a sluice, a pipe, or canal, with a constant velocity.

Thus the general doctrines of motion came to be considered in two points of view, according as they balanced each other in a state of rest or of uniform motion. These two ways of considering the same subject required both different principles and a different manner of reasoning. The first has been named *statics*, as expressing that rest which is the test of this kind of equilibrium. The second has been called DYNAMICS or UNIVERSAL MECHANICS, because the different kinds of motion are characteristic of the powers or forces which produce them. A knowledge of both is indispensably necessary for acquiring any useful practical knowledge of machines; and it was ignorance of the doctrines of accelerated and retarded motions which made the progress of practical mechanical knowledge so very slow and imperfect. The mechanics, even of the moderns, before Galileo, went no further than to state the proportion of the power and resistance which would be balanced by the intervention of a given machine, or the proportion of the parts of a machine by which two known forces may balance each other. This view of the matter introduced a principle, which even Galileo considered as a mechanical axiom, viz. that *what is gained in force by means of a machine is exactly compensated by the additional time which it obliges us to employ*. This is false in every instance, and not only prevents improvement in the construction of machines, but leads us into erroneous maxims of construction. The true principles of dynamics teach us, that there is a certain proportion of the machine, dependent on the kind and proportion of the power and resistance, which enables the machine to perform the greatest possible work.

It is highly proper therefore to keep separate these two ways of considering machines, that both may be improved to the utmost, and then to blend them together in every practical discussion.

Statics therefore is preparatory to the proper study of mechanics; but it does not hence derive all its importance. It is the sole foundation of many useful parts of knowledge. This will be best seen by a brief enumeration.

1. It comprehends all the doctrines of the excitement and propagation of pressure through the parts of solid bodies, by which the energies of machines are produced. A pressure is exerted on the impelled point of a machine, such as the float-boards or buckets of a mill-wheel. This excites a pressure at the pivots of its axle, which act on the points of support. This must be understood, both as to direction and intensity, that it may be effectually resisted. A pressure is also excited at the acting tooth of the cog-wheel on the same axle, by which it urges round another wheel, exciting similar pressures on its pivots and on the acting tooth perhaps of a third wheel.—Thus a pressure is ultimately excited in the working point of the machine, perhaps a wiper, which lifts a heavy stamper, to let it fall again on some matter to be pounded. Now statics teaches us the intensities and direction of all those pressures, and therefore how much remains at the working point of the machine unbalanced by resistance.

2. It comprehends every circumstance which influences the stability of heavy bodies; the investigation and properties of the centre of gravity; the theory of the construction of arches, vaults, and domes; the attitudes of animals.

3. The strength of materials, and the principles of construction, so as to make the proper adjustment of strength and strain in every part of a machine, edifice, or structure of any kind. Statics therefore furnishes us with what may be called *a theory of carpentry*, and gives us proper instructions for framing floors, roofs, centres, &c.

4. Statics comprehends the whole doctrine of the pressure of fluids, whether liquid or aeriform, whether arising from their weight or from any external action. Hence therefore we derive our knowledge of the stability of ships, or their power of maintaining themselves in a position nearly upright, in opposition to the action of the wind on their sails. We learn on what circumstances of figure and stowage this quality depends, and what will augment or diminish it.

Very complete examples will be given in the remaining part of this work of the advantages of this separate consideration of the condition of a machine at rest and in working motion; and in what yet remains to be delivered of the hydraulic doctrines in our account of *WATER-Works* in general, will be perceived the propriety of stating apart the equilibrium which is indicated by the uniform motion of the fluid. The observations too which we have to make on the strength of the materials employed in our edifices or mechanical structures, will be examples of the investigation of those powers, pressures, or strains, which are excited in all their parts.

STATIONARY, in *Astronomy*, the state of a planet when, to an observer on the earth, it appears for some time to stand still, or remain immoveable in the same place in the heavens. For as the planets, to such an observer, have sometimes a progressive motion, and sometimes a retrograde one, there must be some point between the two where they must appear stationary.

STATISTICS, a word lately introduced to express a view or survey of any kingdom, county, or parish.

A Statistical view of Germany was published in 1790 by Mr B. Clarke: giving an account of the imperial and territorial constitutions, forms of government, legislation, administration of justice, and of the ecclesiastical state;

ſtate; with a ſketch of the character and genius of the Germans; a ſhort inquiry into the ſtate of their trade and commerce; and giving a diſtinct view of the dominions, extent, number of inhabitants to a ſquare mile; chief towns, with their ſize and population; revenues, expences, debts, and military ſtrength of each ſtate. In Pruſſia, in Saxony, Sardinia, and Tuſcany, attempts have alſo been made to draw up ſtatiſtical accounts; but they were done rather with a view of aſcertaining the preſent ſtate of theſe countries, than as the means of future improvement.

A grand and extenſive work of this kind, founded on a judicious plan, conducted by the moſt patriotic and enlightened motives, and drawn up from the communications of the whole body of the clergy, was undertaken in Scotland in the year 1790 by Sir John Sinclair of Ulbſter, one of the moſt uſeful members of his country. Many praiſes are heaped upon genius and learning; but to genius and learning no applauſe is due, except when exerted for the benefit of mankind: but gratitude and praiſe is due to him whoſe talents ſhine only in great undertakings, whoſe happineſs ſeems to conſiſt in partriotic exertions, and whoſe judgement is uniformly approved by his ſucceſs. A work of this kind, ſo important in its object, ſo comprehenſive in its range, ſo judicious in its plan, and drawn up by more than 900 men of literary education, many of them men of great genius and learning, muſt be of immenſe value. It was completed about 1799, in 21 volumes 8vo.

The great object of this work is to give an accurate view of the ſtate of the country, its agriculture, its manufactures, and its commerce; the means of improvement, of which they are reſpectively capable; the amount of the population of a ſtate, and the cauſes of its increaſe or decreaſe; the manner in which the territory of a country is poſſeſſed and cultivated; the nature and amount of the various productions of the ſoil; the value of the perſonal wealth or ſtock of the inhabitants, and how it can be augmented; the diſeaſes to which the people are ſubject, their cauſes and their cure; the occupations of the people; where they are entitled to encouragement, and where they ought to be ſuppreſſed; the condition of the poor, the beſt mode of maintaining them, and of giving them employment; the ſtate of ſchools, and other inſtitutions, formed for purpoſes of public utility; the ſtate of the villages and towns, and the regulations beſt calculated for their police and good government; the ſtate of the manners, the morals, and the religious principles of the people, and the means by which their temporal and eternal intereſts can beſt be promoted.

To ſuch of our readers as have not an opportunity of peruſing this national work, or of examining its plan, we will preſent the ſcheme for the ſtatiſtical account of a parochial diſtrict which Sir John Sinclair publiſhed for the conſideration of the clergy, and which has been generally followed by them, though often with great improvements.

The name of the pariſh and its origin; ſituation and extent of the pariſh; number of acres; deſcription of the ſoil and ſurface; nature and extent of the ſea coaſt; lakes, rivers, iſlands, hills, rocks, caves, wood, orchards, &c.; climate and diſeaſes; inſtances of longevity; ſtate of property; number of proprietors; number of reſiding proprietors; mode of cultivation; implements of huſbandry; manures; ſeedtime and harveſt; remarkable inſtances of good and bad ſeaſons; quantity and value of each ſpecies of crop; total value of the whole produce of the diſtrict; total quantity of grain and other articles conſumed in the pariſh; wages and price of labour; ſervices, whether exacted or aboliſhed; commerce; manufactures; manufacture of kelp, its amount, and the number of people employed in it; fiſheries; towns and villages; police; inns and alehouſes; roads and bridges; harbours, ferries, and their ſtate; number of ſhips and veſſels; number of ſeamen; ſtate of the church; ſtipend, manſe, glebe, and patron; number of poor; parochial funds, and the management of them; ſtate of the ſchools, and number of ſcholars; ancient ſtate of population; cauſes of its increaſe or decreaſe; number of families; exact amount of the number of ſouls now living; diviſion of the inhabitants; 1. By the place of their birth; 2. By their ages; 3. By their religious perſuaſions; 4. By their occupations and ſituation in life; 5. By their reſidence, whether in town, village, or in the country; number of houſes; number of uninhabited houſes; number of dove-cots, and to what extent they are deſtructive to the crops; number of horſes, their nature and value; number of cattle, their nature and value; number of ſheep, their nature and value; number of ſwine, their nature and value; minerals in general; mineral ſprings; coal and fuel; eminent men; antiquities; parochial records; miſcellaneous obſervations; character of the people; their manners, cuſtoms, ſtature, &c.; advantages and diſadvantages; means by which their ſituation could be meliorated.

If ſimilar ſurveys (ſays the public-ſpirited editor of this work) were inſtituted in the other kingdoms of Europe, it might be the means of eſtabliſhing, on ſure foundations, the principles of that moſt important of all ſciences, viz. political or ſtatiſtical philoſophy; that is, the ſcience, which, in preference to every other, ought to be held in reverence. No ſcience can furniſh, to any mind capable of receiving uſeful information, ſo much real entertainment, none can yield ſuch important hints for the improvement of agriculture, for the extenſion of commercial induſtry, for regulating the conduct of individuals, or for extending the proſperity of the ſtate; none can tend ſo much to promote the general happineſs of the ſpecies.

STATIUS, Publius Papinius, a celebrated Latin poet of the firſt century, was born at Naples, and was the ſon of Statius, a native of Epirus, who went to Rome to teach poetry and eloquence, and had Domitian for his ſcholar. Statius the poet alſo obtained the favour and friendſhip of that prince; and dedicated to him his Thebais and Achilleis; the firſt in twelve books, and the laſt in two. He died at Naples about the year 100. Beſides the above poems, there are alſo ſtill extant his *Sylvæ*, in five books; the ſtyle of which is purer, more agreeable, and more natural, than that of his Thebais and Achilleis.

STATUARY, a branch of ſculpture, employed in the making of ſtatues. See Sculpture and the next article.

Statuary is one of thoſe arts wherein the ancients ſurpaſſed the moderns; and indeed it was much more popular, and more cultivated, among the former than the latter. It is diſputed between ſtatuary and painting, which of the two is the moſt difficult and the moſt artful.

Statue.

Statuary is alſo uſed for the artificer who makes ſtatues. Phidias was the greateſt ſtatuary among the ancients, and Michael Angelo among the moderns.

STATUE, is defined to be a piece of ſculpture in full relievo, repreſenting a human figure. Daviler more ſcientifically defines ſtatue a repreſentation, in high relievo and inſulate, of ſome perſon diſtinguiſhed by his birth, merit, or great actions, placed as an ornament in a fine building, or expoſed in a public place, to preſerve the memory of his worth. In Greece one of the higheſt honours to which a citizen could aſpire was to obtain a ſtatue.

Statues are formed with the chiſel, of ſeveral matters, as ſtone, marble, plaſter, &c. They are alſo caſt of various kinds of metal, particularly gold, ſilver, braſs, and lead. For the method of caſting ſtatues, ſee the article *FOUNDERY of Statues*.

Statues are uſually diſtinguiſhed into four general kinds. The firſt are thoſe leſs than the life; of which kind we have ſeveral ſtatues of great men, of kings, and of gods themſelves. The ſecond are thoſe equal to the life; in which manner it was that the ancients, at the public expence, uſed to make ſtatues of perſons eminent for virtue, learning, or the ſervices they had done. The third are thoſe that exceed the life; among which thoſe that ſurpaſſed the life once and a half were for kings and emperors; and thoſe double the life, for heroes. The fourth kind were thoſe that exceeded the life twice, thrice, and even more, and were called *coloſſuſes*. See COLOSSUS.

Every ſtatue reſembling the perſon whom it is intended to repreſent, is called *ſtatua iconica*. Statues acquire various other denominations. 1. Thus, allegorical ſtatue is that which, under a human figure, or other ſymbol, repreſents ſomething of another kind; as a part of the earth, a ſeaſon, age, element, temperament, hour, &c. 2. Curule ſtatues, are thoſe which are repreſented in chariots drawn by bigæ or quadrigæ, that is, by two or four horſes; of which kind there were ſeveral in the circuſes, hippodromes, &c. or in cars, as we ſee ſome, with triumphal arches on antique medals. 3. Equeſtrian ſtatue, that which repreſents ſome illuſtrious perſon on horſeback, as that famous one of Marcus Aurelius at Rome; that of King Charles I. at Charing-croſs; King George II. in Leiceſter Square, &c. 4. Greek ſtatue, denotes a figure that is naked and antique; it being in this manner the Greeks repreſented their deities, athletæ of the olympic games, and heroes; the ſtatues of heroes were particularly called *Achillean ſtatues*, by reaſon of the great number of figures of Achilles in moſt of the cities of Greece. 5. Hydraulic ſtatue, is any figure placed as an ornament of a fountain or grotto, or that does the office of a *jet d'eau*, a cock, ſpout, or the like, by any of its parts, or by any attribute it holds: the like is to be underſtood of any animal ſerving for the ſame uſe. 6. Pedeſtrian ſtatue, a ſtatue ſtanding on foot; as that of King Charles II. in the Royal Exchange, and of King James II. in the Privy-Gardens. 7. Roman ſtatue, is an appellation given to ſuch as are clothed, and which receive various names from their various dreſſes. Thoſe of emperors, with long gowns over their armour, were called *ſtatuæ paludatæ*: thoſe of captains and cavaliers, with coats of arms, *thoracatæ*; thoſe of ſoldiers with cuiraſſes, *loricatæ*, thoſe of ſenators and augurs, *trabeatæ*; thoſe of magiſtrates with long robes, *togatæ*; thoſe of the people with a plain tunica, *tunicatæ*; and, laſtly, thoſe of women with long trains, *ſtolatæ*.

Statue ‖ Steam.

In repairing a ſtatue caſt in a mould, they touch it up with a chiſel, graver, or other inſtrument, to finiſh the places which have not come well off: they alſo clear off the barb, and what is redundant in the joints and projectures.

STATURE. See DWARF and GIANT.

STATUTE, in its general ſenſe, ſignifies a law, ordinance, decree, &c. See LAW, &c.

STATUTE, in our laws and cuſtoms, more immediately ſignifies an act of parliament made by the three eſtates of the realm; and ſuch ſtatutes are either general, of which the courts at Weſtminſter muſt take notice without pleading them; or they are ſpecial and private, which laſt muſt be pleaded.

STAVESACRE, a ſpecies of DELPHINIUM, which ſee, BOTANY *Index*.

STAY, a large ſtrong rope employed to ſupport the maſt on the fore part, by extending from its upper end towards the fore part of the ſhip, as the ſhrouds are extended to the right and left, and behind it. See MAST, RIGGING, and SHROUD.

The ſtay of the fore-maſt, which is called the *fore-ſtay*, reaches from the maſt-head towards the bowſprit end: the main ſtay extends over the forecaſtle to the ſhip's ſtem; and the mizen-ſtay is ſtretched down to that part of the main-maſt which lies immediately above the quarter-deck: the fore-top-maſt-ſtay comes alſo to the end of the bowſprit, a little beyond the fore-ſtay: the main-top-maſt ſtay is attached to the head or hounds of the fore-maſt; and the mizen-top-maſt ſtay comes alſo to the hounds of the main-maſt: the fore-top-gallant ſtay comes to the outer end of the jib-boom; and the main-top-gallant ſtay is extended to the head of the fore-top-maſt.

STAY-Sail, a ſort of triangular ſail extended upon a ſtay. See SAIL.

1 Definition.

STEAM, is the name given in our language to the viſible moiſt vapour which ariſes from all bodies which contain juices eaſily expelled from them by heats not ſufficient for their combuſtion. Thus we ſay, the ſteam of boiling water, of malt, of a tan-bed, &c. It is diſtinguiſhed from ſmoke by its not having been produced by combuſtion, by not containing any ſoot, and by its being condenſible by cold into water, oil, inflammable ſpirits, or liquids compoſed of theſe.

2 Appears like a white cloud

We ſee it riſe in great abundance from bodies when they are heated, forming a white cloud, which diffuſes itſelf and diſappears at no very great diſtance from the body from which it was produced. In this caſe the ſurrounding air is found loaded with the water or other juices which ſeem to have produced it, and the ſteam ſeems to be completely ſoluble in air, as ſalt is in water, compoſing while thus united a tranſparent elaſtic fluid.

3 when diſſeminated in air.

But in order to its appearance in the form of an opaque white cloud, the mixture with or diſſemination in air ſeems abſolutely neceſſary. If a tea-kettle boils violently, ſo that the ſteam is formed at the ſpout in great abundance, it may be obſerved, that the viſible cloud is not formed at the very mouth of the ſpout, but at a ſmall diſtance before it, and that the vapour is perfectly tranſparent at its firſt emiſſion. This is rendered ſtill more evident by fitting to the ſpout of the tea-kettle

Steam.

tea-kettle a glaſs pipe of any length, and of as large a diameter as we pleaſe. The ſteam is produced as copiouſly as without this pipe, but the vapour is tranſparent through the whole length of the pipe. Nay, if this pipe communicate with a glaſs veſſel terminating in another pipe, and if the veſſel be kept ſufficiently hot, the ſteam will be as abundantly produced at the mouth of this ſecond pipe as before, and the veſſel will be quite tranſparent. The viſibility therefore of the matter which conſtitutes the ſteam is an accidental or extraneous circumſtance, and requires the admixture with air; yet this quality again leaves it when united with air by ſolution. It appears therefore to require a *diſſemination* in the air. The appearances are quite agreeable to this notion: for we know that one perfectly tranſparent body, when minutely divided and diffuſed among the parts of another tranſparent body, but not diſſolved in it, makes a maſs which is viſible. Thus oil beaten up with water makes a white opaque maſs.

4. Is again converted into water by cold.

In the mean time, as ſteam is produced, the water gradually waſtes in the tea kettle, and will ſoon be totally expended, if we continue it on the fire. It is reaſonable therefore to ſuppoſe, that this ſteam is nothing but water changed by heat into an aerial or elaſtic form. If ſo, we ſhould expect that the privation of this heat would leave it in the form of water again. Accordingly this is fully verified by experiment; for if the pipe fitted to the ſpout of the tea kettle be ſurrounded with cold water, no ſteam will iſſue, but water will continually trickle from it in drops: and if the proceſs be conducted with the proper precautions, the water which we thus obtain from the pipe will be found equal in quantity to that which diſappears from the tea-kettle.

5 Its appearances explained,

This is evidently the common proceſs for diſtilling; and the whole appearances may be explained by ſaying, that the water is converted by heat into an elaſtic vapour, and that this, meeting with colder air, imparts to it the heat which it carried off as it aroſe from the heated water, and being deprived of its heat it is again water. The particles of this water being vaſtly more remote from each other than when they were in the tea-kettle, and thus being diſſeminated in the air, become viſible, by reflecting light from their anterior and poſterior ſurfaces, in the ſame manner as a tranſparent ſalt becomes viſible when reduced to a fine powder. This diſſeminated water being preſented to the air in a very extended ſurface, is quickly diſſolved by it, as pounded ſalt is in water, and again becomes a tranſparent fluid, but of a different nature from what it was before, being no longer convertible into water by depriving it of its heat.

6 and the cauſe of its converſion, by Dr Black's diſcovery of latent heat.

Accordingly this opinion, or ſomething very like it, has been long entertained. Muſchenbroeck expreſsly ſays, that the water in the form of vapour carries off with it all the heat which is continually thrown in by the fuel. But Dr Black was the firſt who attended minutely to the whole phenomena, and enabled us to form diſtinct notions of the ſubject. He had diſcovered that it was not ſufficient for converting ice into water that it be raiſed to that temperature in which it can no longer remain in the form of ice. A piece of ice of the temperature 32° of Fahrenheit's thermometer will remain a very long while in air of the temperature 50° before it be all melted, remaining all the while of the temperature 32°, and therefore continually abſorbing heat from the ſurrounding air. By comparing the time in which the ice had its temperature changed from 28° to 32° with the ſubſequent time of its complete liquefaction, he found that it abſorbed about 130 or 140 times as much heat as would raiſe its temperature one degree; and he found that one pound of ice, when mixed with one pound of water 140 degrees warmer, was juſt melted, but without riſing in its temperature above 32°. Hence he juſtly concluded, that water differed from ice of the ſame temperature by containing, as a conſtituent ingredient, a great quantity of fire, or of the cauſe of heat, united with it in ſuch a way as not to quit it for another colder body, and therefore ſo as not to go into the liquor of the thermometer and expand it. Conſidered therefore as the poſſible cauſe of heat, it was latent, which Dr Black expreſſed by the abbreviated term LATENT HEAT. If any more heat was added to the water it was not latent, but would readily quit it for the thermometer, and, by expanding the thermometer, would ſhow what is the degree of this *redundant* heat, while fluidity alone is the indication of the *combined* and latent heat.

Dr Black, in like manner, concluded, that in order to convert water into an elaſtic vapour, it was neceſſary, not only to increaſe its uncombined heat till its temperature is 212°, in which ſtate it is juſt ready to become elaſtic; but alſo to pour into it a great quantity of fire, or the cauſe of heat, which combines with every particle of it, ſo as to make it repel, or to recede from, its adjoining particles, and thus to make it a particle of an elaſtic fluid. He ſuppoſed that this additional heat might be combined with it ſo as not to quit it for the thermometer; and therefore ſo as to be in a latent ſtate, having elaſtic fluidity for its ſole indication.

7 The temperature at which it is produced, and the quantity of heat which it abſorbs.

This opinion was very conſiſtent with the phenomenon of boiling off a quantity of water. The application of heat to it cauſes it gradually to riſe in its temperature till it reaches the temperature 212°. It then begins to ſend off elaſtic vapour, and is ſlowly expended in this way, continuing all the while of the ſame temperature. The ſteam alſo is of no higher temperature, as appears by holding a thermometer in it. We muſt conclude that this ſteam contains all the heat which is expended in its formation. Accordingly the ſcalding power of ſteam is well known; but it is extremely difficult to obtain preciſe meaſures of the quantity of heat abſorbed by water during its converſion into ſteam. Dr Black endeavoured to aſcertain this point, by comparing the time of raiſing its temperature a certain number of degrees with the time of boiling it off by the ſame external heat; and he found that the heat latent in ſteam, which balanced the preſſure of the atmoſphere, was not leſs than 800 degrees. He alſo directed Dr Irvine of Glaſgow to the form of an experiment for meaſuring the heat actually extricated from ſuch ſteam during its condenſation in the refrigeratory of a ſtill, which was found to be not leſs than 774 degrees. Dr Black was afterwards informed by Mr Watt, that a courſe of experiments, which he had made in each of theſe ways with great preciſion, determined the latent heat of ſteam under the ordinary preſſure of the atmoſphere to be about 948 or 950 degrees. Mr Watt alſo found that water would diſtil with great eaſe

Steam.

in vacuo when of the temperature 70°; and that in this caſe the latent heat of the ſteam is not leſs than 1200 or 1300 degrees: and a train of experiments, which he had made by diſtilling in different temperatures, made him conclude that the ſum of the ſenſible and latent heats is a conſtant quantity. This is a curious and not an improbable circumſtance; but we have no information of the particulars of theſe experiments. The concluſion evidently preſuppoſes a knowledge of that particular temperature in which the water has no heat; but this is a point which is ſtill *ſub judice*.

8 Steam, by being combined with heat, becomes elaſtic and light,

This converſion of liquids (for it is not confined to water, but obtains alſo in ardent ſpirits, oils, mercury, &c.) is the cauſe of their boiling. The heat is applied to the bottom and ſides of the veſſel, and gradually accumulates in the fluid, in a ſenſible ſtate, uncombined, and ready to quit it and to enter into any body that is colder, and to diffuſe itſelf between them. Thus it enters into the fluid of a thermometer, expands it, and thus gives us the indication of the degree in which it has been accumulated in the water; for the thermometer ſwells as long as it continues to abſorb ſenſible heat from the water: and when the ſenſible heat in both is in equilibrio, in a proportion depending on the nature of the two fluids, the thermometer riſes no more, becauſe it abſorbs no more heat or fire from the water; for the particles of water which are in immediate contact with the bottom, are now (by this gradual expanſion of liquidity) at ſuch diſtance from each other, that their laws of attraction for each other and for heat are totally changed. Each particle either no longer attracts, or perhaps it repels its adjoining particle, and now accumulates round itſelf a great number of the particles of heat, and forms a particle of elaſtic fluid, ſo related to the adjoining new formed particles, as to repel them to a diſtance at leaſt a hundred times greater than their diſtances in the ſtate of water. Thus a maſs of elaſtic vapour of ſenſible magnitude is formed. Being at leaſt ten thouſand times lighter than an equal bulk of water, it muſt riſe up through it, as a cork would do, in form of a tranſparent ball or bubble, and getting to the top, it diſſipates, filling the upper part of the veſſel with vapour or ſteam. Thus, by toſſing the liquid into bubbles, which are produced all over the bottom and ſides of the veſſel, it produces the phenomenon of ebullition or boiling. Obſerve, that during its paſſage up through the water, it is not changed or condenſed; for the ſurrounding water is already ſo hot that the ſenſible or uncombined heat in it, is in equilibrio with that in the vapour, and therefore it is not diſpoſed to abſorb any of that heat which is combined as an ingredient of this vapour, and gives it its elaſticity. For this reaſon, it happens that water will not boil till its whole maſs be heated up to 212°; for if the upper part be colder, it robs the riſing bubble of that heat which is neceſſary for its elaſticity, ſo that it immediately collapſes again, and the ſurface of the water remains ſtill. This may be perceived by holding water in a Florence flaſk over a lamp or choffer. It will be obſerved, ſome time before the real ebullition, that ſome bubbles are formed at the bottom, and get up a very little way, and then diſappear. The diſtances which they reach before collapſing increaſe as the water continues to warm farther up the maſs, till at laſt it breaks out into boiling. If the handle of a tea-kettle be graſped with the hand, a tremor will be felt for ſome little time before boiling, ariſing from the little ſucceſſions which are produced by the collapſing of the bubbles of vapour. This is much more violent, and is really a remarkable phenomenon, if we ſuddenly plunge a lump of red hot iron into a veſſel of cold water, taking care that no red part be near the ſurface. If the hand be now applied to the ſide of the veſſel, a moſt violent tremor is felt, and ſometimes ſtrong thumps: theſe ariſe from the collapſing of very large bubbles. If the upper part of the iron be too hot, it warms the ſurrounding water ſo much, that the bubbles from below come up through it uncondenſed, and produce ebullition without this ſucceſſion. The great reſemblance of this tremor to the feeling which we have during the ſhock of an earthquake has led many to ſuppoſe that theſe laſt are produced in the ſame way, and their hypotheſis, notwithſtanding the objections which we have elſewhere ſtated to it, is by no means unfeaſible.

9 and produces the phenomenon of boiling.

10 The noiſe obſerved in the boiling of a tea-kettle explained.

It is owing to a ſimilar cauſe that violent thumps are ſometimes felt on the bottom of a tea-kettle, eſpecially one which has been long in uſe. Such are frequently cruſted on the bottom with a ſtony concretion. This ſometimes is detached in little ſcales. When one of theſe is adhering by one end to the bottom, the water gets between them in a thin film. Hence it may be heated conſiderably above the boiling temperature, and it ſuddenly riſes up in a large bubble, which collapſes immediately. A ſmooth ſhilling lying on the bottom will produce this appearance very violently, or a thimble with the mouth down.

11 Water will not boil unleſs the fire be applied to the bottom or ſides of the veſſel.

In order to make water boil, the fire muſt be applied to the bottom or ſides of the veſſel. If the heat be applied at the top of the water, it will waſte away without boiling; for the very ſuperficial particles are firſt ſupplied with the heat neceſſary for rendering them elaſtic, and they fly off without agitating the reſt (A).

Since this diſengagement of vapour is the effect of its

(A) We explained the opaque and cloudy appearance of ſteam, by ſaying that the vapour is condenſed by coming into contact with the cooler air. There is ſomething in the form of this cloud which is very inexplicable. The particles of it are ſometimes very diſtinguiſhable by the eye; but they have not the ſmart ſtar-like brilliancy of very ſmall drops of water, but give the fainter reflection of a very thin film or veſicle like a ſoap bubble. If we attend alſo to their motion, we ſee them deſcending very ſlowly in compariſon with the deſcent of a ſolid drop; and this veſicular conſtitution is eſtabliſhed beyond a doubt by looking at a candle through a cloud of ſteam. It is ſeen ſurrounded by a faint halo with priſmatical colours, preciſely ſuch as we can demonſtrate by optical laws to belong to a collection of veſicles, but totally different from the halo which would be produced by a collection of ſolid drops. It is very difficult to conceive how theſe veſicles can be formed of watery particles, each of which was ſurrounded its elaſticity, and ſince this elaſticity is a determined force when the temperature is given, it follows, that fluids cannot boil till the elaſticity of the vapour overcomes the preſſure of the incumbent fluid and of the atmoſphere. Therefore, when this preſſure is removed or diminiſhed, the fluids muſt ſooner overcome what remains, and boil at a lower temperature. Accordingly it is obſerved that water will boil in an exhauſted receiver when of the heat of the human body. If two glaſs balls A and B (fig. 1.) be connected by a ſlender tube, and one of them A be filled with water (a ſmall opening or pipe *b* being left at top of the other), and this be made to boil, the vapour produced from it will drive all the air out of the other, and will at laſt come out itſelf, producing ſteam at the mouth of the pipe. When the ball B is obſerved to be occupied by tranſparent vapour, we may conclude that the air is completely expelled. Now ſhut the pipe by ſticking it into a piece of tallow or bees-wax; the vapour in B will ſoon condenſe, and there will be a vacuum. The flame of a lamp and blow-pipe being directed to the little pipe, will cauſe it immediately to cloſe and ſeal hermetically. We now have a pretty inſtrument or toy called a PULSE GLASS. Graſp the ball A in the hollow of the hand; the heat of the hand will immediately expand the bubble of vapour which may be in it, and this vapour will drive the water into B, and then will blow up through it for a long while, keeping it in a ſtate of violent ebullition, as long as there remains a drop or film of water in A. But care muſt be taken that B is all the while kept cold, that it may condenſe the vapour as faſt as it riſes through the water. Touching B with the hand, or breathing warm on it, will immediately ſtop the ebullition in it. When the water in A has thus been diſſipated, graſp B in the hand; the water will be driven into A, and the ebullition will take place there as it did in B. Putting one of the balls into the mouth will make the ebullition more violent in the other, and the one in the mouth will feel very cold. This is a pretty illuſtration of the rapid abſorption of the heat by the particles of water which are thus converted into elaſtic vapour. We have ſeen this little toy ſuſpended by the middle of the tube like a balance, and thus placed in the inſide of a window, having two holes *a* and *b* cut in the pane, in ſuch a ſituation that when A is full of water and preponderates, B is oppoſite to the hole *b*. Whenever the room became ſufficiently warm, the vapour was formed in A, and immediately drove the water into B, which was kept cool by the air coming into the room through the hole *b*. By this means B was made to preponderate in its turn, and A was then oppoſite to the hole *a*, and the proceſs was now repeated in the oppoſite direction; and this amuſement continued as long as the room was warm enough.

12
No fluid can boil till the elaſticity of the vapour overcome the preſſure of the incumbent bodies.
Plate DI. Fig. 1.

13
Liquors differ much in the temperature neceſſary for their ebullition.

We know that liquors differ exceedingly in the temperatures neceſſary for their ebullition. This forms the great chemical diſtinction between volatile and fixed bodies. But the difference of temperature in which they boil, or are converted into permanently elaſtic vapour, under the preſſure of the atmoſphere, is not a certain meaſure of their differences of volatility. The natural boiling point of a body is that in which it will be converted into elaſtic vapour under no preſſure, or *in vacuo*. The boiling point in the open air depends on the law of the elaſticity of the vapour in relation to its heat. A fluid A may be leſs volatile, that is, may require more heat to make it boil *in vacuo*, than a fluid B: But if the elaſticity of the vapour of A be more increaſed by an increaſe of temperature than that of the vapour of B, A may boil at as low, or even at a lower temperature, in the open air, than B does; for the increaſed elaſticity of the vapour of A may ſooner overcome the preſſure of the atmoſphere. Few experiments have been made on the relation between the temperature and the elaſticity of different vapours. So long ago as the year 1765, we had occaſion to examine the boiling points of all ſuch liquors as we could manage in an air-pump; that is, ſuch as did not produce vapours which deſtroyed the valves and the leathers of the piſtons: and we thought that the experiments gave us reaſon to conclude, that the elaſticity of all the vapours was affected by heat nearly in the ſame degree. For we found that the difference between their boiling points in the air and *in vacuo* was nearly the ſame in all, namely, about 120 degrees of Fahrenheit's thermometer. It is exceedingly difficult to make experiments of this kind: The vapours are ſo condenſible, and change their elaſticity ſo prodigiouſly by a trifling change of temperature, that it is almoſt impoſſible to examine this point with preciſion. It is, however, as we ſhall ſee by and bye, a ſubject of conſiderable practical importance in the mechanic arts; and an accurate knowledge of the relation would be of great uſe alſo to the diſtiller: and it would be no leſs important to diſcover the relation of their elaſticity and denſity, by examining their compreſſibility, in the ſame manner as we have aſcertained the relation in the caſe of what we call *aerial fluids*, that is, ſuch as we have never obſerved in the form of liquids or ſolids, except in conſequence of their union with each other or with other bodies. In the article PNEUMATICS we took notice of it as ſomething like a natural law, that all theſe airs, or gaſes as they are now called, had their elaſticity very nearly, if not exactly proportional to their denſity. This appears from the experiments of Achard, of Fontana, and others, on vital air, inflammable air, fixed air, and ſome others. It gives us ſome preſumption to ſuppoſe that it holds in all elaſtic vapours whatever, and that it is connected with their elaſticity; and it renders it ſomewhat probable that they are all elaſtic, only becauſe the cauſe of heat (the matter of fire if you will) is elaſtic, and that their law of elaſticity, in reſpect of denſity, is the ſame with that of fire. But it muſt be

14
Difference between their boiling points in air and *in vacuo* about 120°.

rounded with many particles of fire, now communicated to the air, and how each of theſe veſicles ſhall include within it a ball of air; but we cannot refuſe the fact. We know, that if, while linſeed oil is boiling or nearly boiling, the ſurface be obliquely ſtruck with the ladle, it will be daſhed into a prodigious number of exceedingly ſmall veſicles, which will float about in the air for a long while. Mr Sauſſure was (we think) the firſt who diſtinctly obſerved this veſicular form of miſts and clouds; and he makes conſiderable uſe of it in explaining ſeveral phenomena of the atmoſphere.

Steam.

15
To what the elasticity of fluids may be owing.

be obferved, that although we thus affign the elafticity of fire as the immediate caufe of the elafticity of vapour, in the fame way, and on the fame grounds, that we afcribe the fluidity of brine to the fluidity of the water which holds the folid falt in folution, it does not follow that this is owing, as is commonly fuppofed, to a repulfion or tendency to recede from each other exerted by the particles of fire. We are as much entitled to infer a repulfion of unlimited extent between the particles of water; for we fee that by its means a fingle particle of fea-falt becomes diffeminated through the whole of a very large veffel. If water had not been a vifible and palpable fubftance, and the falt only had been vifible and palpable, we might have formed a fimilar notion of chemical folution. But we, on the contrary, have confidered the *quaquaverfum* motion or expanfion of the falt as a diffemination among the particles of water; and we have afcribed it to the ftrong attraction of the atoms of falt for the atoms of water, and the attraction of thefe laft for each other, thinking that each atom of falt accumulates round itfelf a multitude of watery atoms, and by fo doing muft recede from the other faline atoms. Nay, we farther fee, that by forces which we naturally confider as attractions, an expanfion may be produced of the whole mafs, which will act againft external mechanical forces. It is thus that wood fwells with almoft infuperable force by imbibing moifture; it is thus that a fponge immerfed in water becomes really an elaftic compreffible body; refembling a blown bladder; and there are appearances which warrant us to apply this mode of conception to elaftic fluids.—When air is fuddenly compreffed, a thermometer included in it fhows a rife of temperature; that is, an appearance of heat now redundant which was formerly combined. The heat feems to be fqueezed out as the water from the fponge.

16
Afcribed by fome to attraction, but improperly.

Accordingly this opinion, that the elafticity of fteam and other vapours is owing merely to the attraction for fire, and the confequent diffemination of their particles through the whole mafs of fire, has been entertained by many naturalifts, and it has been afcribed entirely to attraction. We by no means pretend to decide; but we think the analogy by far too flight to found any confident opinion on it. The aim is to folve phenomena by attraction only, as if it were of more eafy conception than repulfion. Confidered merely as facts, they are quite on a par. The appearances of nature in which we obferve actual receffes of the parts of body from each other, are as diftinct, and as frequent and familiar, as the appearances of actual reproach. And if we attempt to go farther in our contemplation, and to conceive the way and the forces by which either the approximation or receffes of the atoms are produced, we muft acknowledge that we have no conception of the matter; and we can only fay, that there is a caufe of thefe motions, and we call it a force, as in every cafe of the production of motion. We call it attraction or repulfion juft as we happen to contemplate an accefs or a recefs. But the analogy here is not only flight, but imperfect, and fails moft in thofe cafes which are moft fimple, and where we fhould expect it to be moft complete. We can fqueeze water out of a fponge, it is true, or out of a piece of green wood; but when the white of an egg, the tremella, or fome gums, fwell to a hundred times their dry dimenfions by imbibing water, we cannot fqueeze out a particle. If fluidity (for the reafoning muft equally apply to this as to vapouroufnefs) be owing to an accumulation of the extended matter of fire, which gradually expanded the folid by its very minute additions; and if the accumulation round a particle of ice, which is neceffary for making it a particle of water, be fo great in comparifon of what gives it the expanfion of one degree, as experiment obliges us to conclude—it feems an inevitable confequence that all fluids fhould be many times rarer than the folids from which they are produced. But we know that the difference is trifling in all cafes, and in fome (water, for inftance, and iron) the folid is rarer than the fluid. Many other arguments, (each of them perhaps of little weight when taken alone, but which are all fyftematically connected) concur in rendering it much more probable that the matter of fire, in caufing elafticity, acts immediately by its own elafticity, which we cannot conceive in any other way than as a mutual tendency in its particles to receive from each other; and we doubt not but that, if it could be obtained alone, we fhould find it an elaftic fluid like air. We even think that there are cafes in which it is obferved in this ftate. The elaftic force of gunpowder is very much beyond the elafticity of all the vapours which are produced in its deflagration, each of them being expanded as much as we can reafonably fuppofe by the great heat to which they are expofed. The writer of this article exploded fome gunpowder mixed with a confiderable portion of finely powdered quartz, and another parcel mixed with fine filings of copper. The elafticity was meafured by the penetration of the ball which was difcharged, and was great in the degree now mentioned. The experiment was fo conducted, that much of the quartz and copper was collected; none of the quartz had been melted, and fome of the copper was not melted. The heat, therefore, could not be fuch as to explain the elafticity by expanfion of the vapours; and it became not improbable that fire was acting here as a detached chemical fluid by its own elafticity. But to return to our fubject.

17
More probably owing to a mutual repulfion between the particles of fire.

18
Probably a great difference between condenfible and incondenfible vapours;

There is one circumftance in which we think our own experiments fhow a remarkable difference (at leaft in degree) between the condenfible and incondenfible vapours. It is well known, that when air is very fuddenly expanded, cold is produced, and heat when it is fuddenly condenfed. When making experiments with the hopes of difcovering the connection between the elafticity and denfity of the vapours of boiling water, and alfo of boiling fpirits of turpentine, we found the change of denfity accompanied by a change of temperature vaftly greater than in the cafe of incoercible gafes. When the vapour of boiling water was fuddenly allowed to expand into five times its bulk, we obferved the depreffion of a large and fenfible air thermometer to be at leaft four or five times greater than in a fimilar expanfion of common air of the fame temperature. The chemical reader will readily fee reafons for expecting, on the contrary, a fmaller alteration of temperature, both on account of the much greater rarity of the fluid, and on account of a partial condenfation of its water and the confequent difengagement of combined heat.

19
and alfo fome difference in the chemical conftitution of vapour.

This difference in the quantity of fire which is combined in vapours and gafes is fo confiderable, as to authorize us to fuppofe that there is fome difference in the chemical conftitution of vapours and gafes, and that the connection

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connection between the specific bases of the vapour and the fire which it contains is not the same in air, for instance, as in the vapour of boiling water; and this difference may be the reason why the one is easily condensible by cold, while the other has never been exhibited in a liquid or solid form, except by means of its chemical union with other substances. In this particular instance we know that there is an essential difference—that in vital or atmospheric air there is not only a prodigious quantity of fire which is not in the vapour of water, but that it also contains light, or the cause of light, in a combined state. This is fully evinced by the great discovery of Mr Cavendish of the composition of water. Here we are taught that water (and consequently its vapour) consists of air from which the light and greatest part of the fire have been separated. And the subsequent discoveries of the celebrated Lavoisier show, that almost all the condensible gases with which we are acquainted consist either of airs which have already lost much of their fire (and perhaps light too), or of matters in which we have no evidence of fire or light being combined in this manner.

This consideration may go far in explaining this difference in the condensibility of these different species of aerial fluids, the gases and the vapours; and it is with this qualification only that we are disposed to allow that all bodies are condensible into liquids or solids by abstracting the heat. In order that vital air may become liquid or solid, we hold that it is not sufficient that a body be presented to it which shall simply abstract its heat. This would only abstract its uncombined fire. But another and much larger portion remains chemically combined by means of light. A chemical affinity must be brought into action which may abstract, not the fire from the oxygen (to speak the language of Mr Lavoisier), but the oxygen from the fire and light. And our production is not the detached basis of air, but detached heat and light, and the formation of an oxide of some kind.

General Observations.

To prosecute the chemical consideration of Steams farther than these general observations, which are applicable to all, would be almost to write a treatise of chemistry, and would be a repetition of many things which have been treated of in sufficient detail in other articles of this work. We shall therefore conclude this article with some other observations, which are also general, with respect to the different kinds of coercible vapours, but which have a particular relation to the following article.

20

Steam rises at different temperatures, according as the air is heavy or light.

Steam or vapour is an elastic fluid, whose elasticity balances the pressure of the atmosphere; and it has been produced from a solid or liquid body raised to a sufficient temperature for giving it this elasticity; that is, for causing the fluid to boil. This temperature must vary with the pressure of the air. Accordingly it is found, that when the air is light (indicated by the barometer being low), the fluid will boil sooner. When the barometer stands at 30 inches, water boils at the temperature 212°. If it stands so low as 28 inches, water will boil at $208\frac{1}{2}$. In the plains of Quito, or at Gondar in Abyssinia, where the barometer stands at about 21 inches, water will boil at 195°. Highly rectified alcohol will boil at 160°, and vitriolic ether will boil at 88° or 89°. This is a temperature by no means uncommon in these places; nay, the air is frequently warmer. Vitriolic ether, therefore, is a liquor which can hardly be known in those countries. It is hardly possible to preserve it in that form. If a phial have not its stopper firmly tied down, it will be blown out, and the liquor will boil and be dissipated in steam. On the top of Chimboraçao, the human blood must be disposed to give out air-bubbles.

21

As fluids under the pressure of the vapour which ascends from them, the conclusion mentioned in no 14. is only a gross approximation.

We said some time ago, that we had concluded, from some experiments made in the receiver of an air-pump, that fluids boil *in vacuo* at a temperature nearly 120 degrees lower than that necessary for their boiling in the open air. But we now see that this must have been but a gross approximation; for in these experiments the fluids were boiling under the pressure of the vapour which they produced, and which could not be abstracted by working the pump. It appears from the experiments of Lord Charles Cavendish, mentioned in the article Pneumatics, that water of the temperature 72° was converted into elastic vapour, which balanced a pressure of $\frac{3}{4}$ths of an inch of mercury, and in this state it occupied the receiver, and did not allow the mercury in the gauge to sink to the level. As fast as this was abstracted by working the air-pump, more of it was produced from the surface of the water, so that the pressure continued the same, and the water did not boil. Had it been possible to produce a vacuum above this water, it would have boiled for a moment, and would even have continued to boil, if the receiver could have been kept very cold.

22

Account of experiments to determine the relation between the temperature of vapour and its elasticity.

Upon reading these experiments, and some very curious ones of Mr Nairne, in the Phil. Transf. vol. lxvii. the writer of this article was induced to examine more particularly the relation between the temperature of the vapour and its elasticity, in the following manner:

Fig. 2.

ABCD (fig. 2.) is the section of a small digester made of copper. Its lid, which is fastened to the body with screws, is pierced with three holes, each of which had a small pipe soldered into it. The first hole was furnished with a brass safety-valve V, nicely fitted to it by grinding. The area of this valve was exactly $\frac{1}{4}$th of an inch. There rested on the stalk at top of this valve the arm of a steelyard carrying a sliding weight. This arm had a scale of equal parts, so adjusted to the weight that the number on the scale corresponded to the inches of mercury, whose pressure on the under surface of the valve is equal to that of the steelyard on its top; so that when the weight was at the division 10, the pressure of the steelyard on the valve was just equal to that of a column of mercury 10 inches high, and $\frac{1}{4}$th of an inch base. The middle hole contained a thermometer T firmly fixed into it, so that no vapour could escape by its sides. The ball of this thermometer was but a little way below the lid. The third hole received occasionally the end of a glass-pipe SGF, whose descending leg was about 36 inches long. When this syphon was not used, the hole was properly shut with a plug.

The vessel was half filled with distilled water which had been purged of air by boiling. The lid was then fixed on, having the third hole S plugged up. A lamp being placed under the vessel, the water boiled, and the steam issued copiously by the safety-valve. The thermometer stood at 213, and a barometer in the room at 29.9 inches. The weight was then put on the fifth division. The thermometer immediately began to rise; and when it was at 220, the steam issued by the sides of

Steam. of the valve. The weight was removed to the 10th divifion; but before the thermometer could be diftinctly obferved, the fteam was iffuing at the valve. The lamp was removed farther from the bottom of the veffel, that the progrefs of heating might be more moderate; and when the fteam ceafed to iffue from the valve, the thermometer was at 227. The weight was now fhifted to 15; and by gradually approaching the lamp, the fteam again iffued, and the thermometer was at $132\frac{1}{2}$. This mode of trial was continued all the way to the 75th divifion of the fcale. The experiments were then repeated in the contrary order; that is, the weight being fufpended at the 75th divifion, and the fteam iffuing ftrongly at the valve, the lamp was withdrawn, and the moment the fteam ceafed to come out, the thermometer was obferved. The fame was done at the 70th, 65th, divifion, &c. Thefe experiments were feveral times repeated both ways; and the means of all the refults for each divifion are expreffed in the following table, where column 1ft expreffes the elafticity of the fteam, being the fum of 29.9, and the divifion of the fteelyard; column 2d expreffes the temperature of the fteam correfponding to this elafticity.

I.	II.
35 inches.	219°
40	226
45	232
50	237
55	242
60	247
65	251
70	255
75	259
80	263
85	267
90	$270\frac{1}{2}$
95	$274\frac{1}{2}$
100	278
105	281

A very different procefs was neceffary for afcertaining the elafticity of the fteam in lower temperatures, and confequently under fmaller preffures than that of the atmofphere. The glafs fyphon SGF was now fixed into its hole in the lid of the digefter. The water was made to boil fmartly for fome time, and the fteam iffued copioufly both at the valve and at the fyphon. The lower end of the fyphon was now immerfed into a broad faucer of mercury, and the lamp inftantly removed, and every thing was allowed to grow cold. By this the fteam was gradually condenfed, and the mercury rofe in the fyphon, without fenfibly finking in the faucer. The valve and all the joints were fmeared with a thick clammy cement, compofed of oil, tallow, and rofin, which effectually prevented all ingrefs of air. The weather was clear and frofty, and the barometer ftanding at 29.84, and the thermometer in the veffel at 42°. The mercury in the fyphon ftood at 29.7, or fomewhat higher, thus fhowing a very complete condenfation. The whole veffel was furrounded with pounded ice, of the temperature 32°. This made no fenfible change in the height of the mercury. A mark was now made at the furface of the mercury. One obferver was ftationed at the thermometer, with inftructions to call out as the thermometer reached the divifions 42, 47, 52, 57, and fo on by every five degrees till it fhould attain the boiling heat. Another obferver noted the correfponding defcents of the mercury by a fcale of inches, which had its beginning placed at 29.84 from the furface of the mercury in the faucer. Steam.

The pounded ice was now removed, and the lamp placed at a confiderable diftance below the veffel, fo as to warm its contents very flowly. Thefe obfervations being very eafily made, were feveral times repeated, and their mean refults are fet down in the following table: Only obferve, that it was found difficult to note down the defcents for every fifth degree, becaufe they fucceeded each other fo faft. Every 10th was judged fufficient for eftablifhing the law of variation. The firft column of the table contains the temperature, and the fecond the defcent (in inches) of the mercury from the mark 29.84.

32°	☿
40	0.1
50	0.2
60	0.35
70	0.55
80	0.82
90	1.18
100	1.61
110	2.25
120	3.00
130	3.95
140	5.15
150	6.72
160	8.65
170	11.05
180	14.05
190	17.85
200	22.62
210	28.65

Four or five numbers at the top of the column of elafticities are not fo accurate as the others, becaufe the mercury paffed pretty quickly through thefe points. But the progrefs was extremely regular through the remaining points; fo that the elafticities correfponding to temperatures above 70° may be confidered as very accurately afcertained.

Not being altogether fatisfied with the method employed for meafuring the elafticity in temperatures above that of boiling water, a better form of experiment was adopted. (Indeed it was the want of other apparatus which made it neceffary to employ the former). A glafs tube was procured of the form reprefented in fig. 3. having a little ciftern L, from the top and bottom of which proceeded the fyphons K and MN. The ciftern contained mercury, and the tube MN was of a flender bore, and was about fix feet two inches long. The end K was firmly fixed in the third hole of the lid, and the long leg of the fyphon was furnifhed with a fcale of inches, and firmly faftened to an upright poft. Fig. 3.

The lamp was now applied at fuch a diftance from the veffel as to warm it flowly, and make the water boil, the fteam efcaping for fome time through the fafety-valve. A heavy weight was then fufpended on the fteelyard; fuch as it was known that the veffel would fupport, and at the fame time, fuch as would not allow the fteam to force the mercury out of the long tube. The thermometer began immediately to rife, as alfo the mercury

Steam.

mercury in the tube MN. Their correfpondent ftations are marked in the following table :

Temperature.	*Elafticity.*
212°	0.0
220	5.9
230	14.6
240	25.0
250	36.9
260	50.4
270	64.2
280	106.0

This form of the experiment is much more fufceptible of accuracy than the other, and the meafures of elafticity are more to be depended on. In repeating the experiment, they were found much more conftant ; whereas, in the former method, differences occurred of two inches and upwards.

We may now connect the two fets of experiments into one table, by adding to the numbers in this laft table the conftant height 29.9, which was the height of the mercury in the barometer during the laft fet of obfervations.

Temperature.	*Elafticity.*
32°	0.0
40	0.1
50	0.1
60	0.35
70	0.55
80	0.82
90	1.25
100	1.6
110	2.25
120	3.0
130	3.95
140	5.15
150	6.72
160	8.65
170	11.05
180	14.05
190	17.85
200	22.62
210	28.65
220	35.8
230	44.7
240	54.9
250	66.8
260	80.3
270	94.1
280	105.9

23
Which agree well with thofe of Mr Achard.

In the memoirs of the Royal Academy of Berlin for 1782, there is an account of fome experiments made by Mr Achard on the elaftic force of fteam, from the temperature 32° to 212°. They agree extremely well with thofe mentioned here, rarely differing more than two or three tenths of an inch. He alfo examined the elafticity of the vapour produced from alcohol, and found, that when the elafticity was equal to that of the vapour of water, the temperature was about 35° lower. Thus, when the elafticity of both was meafured by 28.1 inches of mercury, the temperature of the watery vapour was 209°, and that of the fpirituous vapour was 173°. When the elafticity was 18.5, the temperature of the water was 189.5, and that of the alcohol 154.6. When the elafticity was 11.05, the water was 168°, and the alcohol 134°.4. Obferving the difference between the temperatures of equally elaftic vapours of water and alcohol not to be conftant, but gradually to diminifh, in Mr Achard's experiments, along with the elafticity, it became interefting to difcover whether and at what temperature this difference would vanifh altogether. Experiments were accordingly made by the writer of this article, fimilar to thofe made with water. They were not made with the fame fcrupulous care, nor repeated as they deferved, but they furnifhed rather an unexpected refult. The following table will give the reader a diftinct notion of them :

Temperature.	*Elafticity.*
32°	0.0
40	0.1
60	0.8
80	0.8
100	3.9
120	6.9
140	12.2
160	21.3
180	34.
200	52.4
220	78.5
240	115.

24
An unexpected refult in comparing the temperatures of equally elaftic vapours of water and alcohol.

We fay that the refult was unexpected ; for as the natural boiling point feemed by former experiments to be in all fluids about 120° or more below their boiling point in the ordinary preffure of the atmofphere, it was reafonable to expect that the temperature at which they ceafed to emit fenfibly elaftic fteam would have fome relation to their temperatures when emitting fteam of any determinate elafticity. Now as the vapour of alcohol of elafticity 30 has its temperature about 36° lower than the temperature of water equally elaftic, it was to be expected that the temperature at which it ceafed to be fenfibly affected would be feveral degrees lower than 32°. It is evident, however, that this is not the cafe. But this is a point that deferves more attention, becaufe it is clofely connected with the chemical relation between the element (if fuch there be) of fire and the bodies into whofe compofition it feems to enter as a conftituent part. What is the temperature 32°, to make it peculiarly connected with elafticity ? It is a temperature affumed by us for our own conveniency, on account of the familiarity of water in our experiments. Ether, we know, boils in a temperature far below this, as appears from Dr Cullen's experiments narrated in the Effays Phyfical and Literary of Edinburgh. On the faith of former experiments, we may be pretty certain that it will boil in vacuo at the temperature —14°, becaufe in the air it boils at +106°. Therefore we may be certain, that the fteam or vapour of ether, when of the temperature 32°, will be very fenfibly elaftic. Indeed Mr Lavoifier fays, that if it be expofed in an exhaufted receiver in winter, its vapour will fupport mercury at the height of 10 inches. A feries of experiments on this vapour fimilar to the above would be very inftructive. We even wifh that thofe on alcohol were more carefully repeated. If we draw a curve line, of which the abfciffa is the line of temperatures, and the ordinates are the correfponding heights of the mercury in thefe experiments on water and alcohol,

Steam.

we shall obseive, that although they both sensibly coincide at 32°, and have the abscissa for their common tangent, a very small error of observation may be the cause of this, and the curve which expresses the elasticity of spirituous vapour may really intersect the other, and go backwards considerably beyond 32°.

25
These experiments give rise to important reflections.

This range of experiments gives rise to some curious and important reflections. We now see that no particular temperature is necessary for water assuming the form of permanently elastic vapour; and that it is highly probable that it assumes this form even at the temperature 32°; only its elasticity is too small to afford us any sensible measure. It is well known that even ice evaporates (see experiments to this purpose by Mr Wilson in the Philosophical Transactions, when a piece of polished metal covered with hoar-frost became perfectly clear by exposing it to a dry frosty wind). Vol. lxx.

Even mercury evaporates, or is converted into elastic vapour, when all external pressure is removed. The dim film which may frequently be observed in the upper part of a barometer which stands near a stream of air, is found to be small globules of mercury sticking to the inside of the tube. They may be seen by the help of a magnifying glass, and are the best test of a well made barometer. They will be entirely removed by causing the mercury to rise along the tube. It will lick them all up. They consist of mercury which had evaporated in the void space, and was afterwards condensed by the cold glass. But the elasticity is too small to occasion a sensible depression of the column, even when considerably warmed by a candle.

26
Spontaneous evaporation produced by the dissolving power of the air.

Many philosophers accordingly imagine, that spontaneous evaporation in low temperatures is produced in this way. But we cannot be of this opinion, and must still think that this kind of evaporation is produced by the dissolving power of the air. When moist air is suddenly rarefied, there is always a precipitation of water. This is most distinctly seen when we work an air-pump briskly. A mist is produced, which we see plainly fall to the bottom of the receiver. But by this new doctrine the very contrary should happen, because the tendency of water to appear in the elastic form is promoted by removing the external pressure; and we really imagine that more of it now actually becomes simple elastic watery vapour. But the mist or precipitation shows incontrovertibly, that there had been a previous solution. Solution is performed by forces which act in the way of attraction; or, to express it more safely, solutions are accompanied by the mutual approaches of the particles of the menstruum and solved: all such tendencies are *observed* to increase by a diminution of distance. Hence it *must* follow, that air of double density will dissolve more than twice as much water. Therefore when we suddenly rarefy saturated air (even though its heat should not diminish) some water must be let go. What may be its quantity we know not; but it *may be more* than what would now become elastic by this diminution of surrounding pressure; and it is not unlikely but this may have some effect in producing the vesicles which we found so difficult to explain. These may be filled with pure watery vapour, and be floating in a fluid composed of water dissolved in air. An experiment of Fontana's seems to put this matter out of doubt. A distilling apparatus AB (fig. 4.) was so contrived, that the heat was applied above the surface of the water in the alembic A. This was done by inclosing it in another vessel CC, filled with hot water. In the receiver B there was a sort of barometer D, with an open cistern, in order to see what pressure there was on the surface of the fluid. While the receiver and alembic contained air, the heat applied at A produced no sensible distillation during several hours: But on opening a cock E in the receiver at its bottom, and making the water in the alembic to boil, steam was produced which soon expelled all the air, and followed it through the cock. The cock was now shut, and the whole allowed to grow cold by removing the fire, and applying cold water to the alembic. The barometer fell to a level nearly. Then warm water was allowed to get into the outer vessel CC. The barometer rose a little, and the distillation went on briskly without the smallest ebullition in the alembic. The conclusion is obvious: while there was air in the receiver and communicating pipe, the distillation proceeded entirely by the dissolving power of this air. Above the water in the alembic it was quickly saturated; and this saturation proceeded slowly along the still air in the communicating pipe, and at last might take place through the whole of the receiver. The sides of the receiver being kept cold, should condense part of the water dissolved in the air in contact with them, and this should trickle down the sides and be collected. But any person who has observed how long a crystal of blue vitriol will lie at the bottom of a glass of still water before the tinge will reach the surface, will see that it must be next to impossible for distillation to go on in these circumstances; and accordingly none was observed. But when the upper part of the apparatus was filled with pure watery vapour, it was supplied from the alembic as fast as it was condensed in the receiver, just as in the pulse glass.

Fig. 4.

27
A certain law in the dilatation of aeriform fluids by heat.

Another inference which may be drawn from these experiments is, that Nature seems to affect a certain law in the dilatation of aeriform fluids by heat. They seem to be dilatable nearly in proportion of their present dilatation. For if we suppose that the vapours resemble air, in having their elasticity in any given temperature proportional to their density, we must suppose that if steam of the elasticity 60, that is, supporting 60 inches of mercury, were subjected to a pressure of 30 inches, it would expand into twice its present bulk. The augmentation of elasticity therefore is the measure of the bulk into which it would expand in order to acquire its former elasticity. Taking the increase of elasticity therefore as a measure of the bulk into which it would expand under one constant pressure, we see that equal increments of temperature produce nearly equal multiplications of bulk. Thus if a certain diminution of temperature diminishes its bulk $\frac{1}{4}$th, another equal diminution of temperature will diminish this new bulk $\frac{1}{4}$th very nearly. Thus, in our experiments, the temperatures 110°, 140°, 170°, 200°, 230°, are in arithmetical progression, having equal differences; and we see that the corresponding elasticities 2.25, 5.15, 11.05, 22.62, 44.7, are very nearly in the continued proportion of 1 to 2. The elasticity corresponding to the temperature 260 deviates considerably from this law, which would give 88 or 89 instead of 80; and the deviation

Steam.

deviation increafes in the higher temperatures. But ftill we fee that there is a confiderable approximation to this law; and it will frequently affift us to recollect, that whatever be the prefent temperature, an increafe of 30 degrees doubles the elafticity and the bulk of watery vapour.

That 4° will increafe the elafticity from			1 to $1\frac{1}{10}$
8	-	-	1 to $1\frac{1}{5}$
10	-	-	1 to $1\frac{1}{4}$
$12\frac{1}{2}$	-	-	1 to $1\frac{1}{3}$
18	-	-	1 to $1\frac{1}{2}$
22	-	-	1 to $1\frac{2}{3}$
24	-	-	1 to $1\frac{3}{4}$
26	-	-	1 to $1\frac{4}{5}$

This is fufficiently exact for moft practical purpofes. Thus an engineer finds that the injection cools the cylinder of a fteam-engine to 192°. It therefore leaves a fteam whofe elafticity is three-fifths of its full elafticity, = 18 inches ☿. But it is better at all times to have recourfe to the table. Obferve, too, that in the lower temperatures, i. e. below 110°, this increment of temperature does more than double the elafticity.

28
Obtains more remarkably in the incoercible vapours.

This law obtains more remarkably in the incoercible vapours; fuch as vital air, atmofpheric air, fixed air, &c. all of which have alfo their elafticity proportional to their bulk inverfely: and perhaps the deviation from the law in fteams is connected with their chemical difference of conftitution. If the bulk were always augmented in the fame proportion by equal augmentations of temperature, the elafticities would be accurately reprefented by the ordinates of a logarithmic curve, of which the temperatures are the correfponding abfciffæ; and we might contrive fuch a fcale for our thermometer, that the temperatures would be the common logarithms of the elafticities, or of the bulks having equal elafticity; or, with our prefent fcale, we may find fuch a multiplier m for the number x of degrees of our thermometer (above that temperature where the elafticity is equal to unity), that this multiple fhall be the common logarithm of the elafticity y; fo that $mx = \log. y$.

But our experiments are not fufficiently accurate for determining the temperature where the elafticity is meafured by 1 inch; becaufe in thefe temperatures the elafticities vary by exceedingly fmall quantities. But if we take 11.04 for the unit of elafticity, and number our temperature from 170°, and make $m = 0.010035$, we fhall find the product mx to be very nearly the logarithm of the elafticity. The deviations, however, from this law, are too great to make this equation of any ufe. But it is very practicable to frame an equation which fhall correfpond with the experiments to any degree of accuracy; and it has been done for air in a tranflation of General Roy's Meafurement of the Bafe at Hounflow Heath into French by Mr Prony. It is as follows: Let x be the degrees of Reaumur's thermometer; let y be the expanfion of 10.000 parts of air; let e be $= 10$, $m = 2.7979$, $n = 0.01768$: then $y = e^{m+nx} - 627.5$. Now e being $= 10$, it is plain that e^{m+nx} is the number, of which $m+nx$ is the common logarithm. This formula is very exact as far as the temperature 60°: but beyond this it needs a correction; becaufe air, like the vapour of water, does not expand in the exact proportion of its bulk.

29
And is confiderably approximated to in the augmentation of the bulk or elafticity of elaftic vapours.

We obferve this law confiderably approximated to in the augmentation of the bulk or elafticity of elaftic vapours; that is, it is a fact that a given increment of temperature makes very nearly the fame proportional augmentation of bulk and elafticity. This gives us fome notion of the manner in which the fuppofed expanding caufe produces the effect. When vapour of the bulk 4 is expanded into a bulk 5 by an addition of 10 degrees of fenfible heat, a certain quantity of fire goes into it, and is accumulated round each particle, in fuch a manner that the temperature of each, which formerly was m, is now $m+10$. Let it now receive another equal augmentation of temperature. This is now $m+20$, and the bulk is $\frac{5\times 5}{4}$ or $6\frac{1}{4}$, and the arithmetical increafe of bulk is $1\frac{1}{4}$. The abfolute quantity of fire which has entered it is greater than the former, both on account of the greater augmentation of fpace and the greater temperature. Confequently if this vapour be compreffed into the bulk 5, there muft be heat or fire in it which is not neceffary for the temperature $m+20$, far lefs for the temperature $m+10$. It muft therefore emerge, and be difpofed to enter a thermometer which has already the temperature $m+20$: that is, the vapour muft grow hotter by compreffion; not by fqueezing out the heat, like water out of a fponge, but becaufe the law of attraction for heat is deranged. It would be a very valuable acquifition to our knowledge to learn with precifion the quantity of fenfible heat produced in this way; but no fatisfactory experiments have yet been made. M. Lavoifier, with his chemical friends and colleagues, were bufily employed in this inquiry: but the wickednefs of their countrymen deprived the world of this and many other important additions which we might have expected from this celebrated and unfortunate philofopher. He had made, in conjunction with M. de la Place, a numerous train of accurate and expenfive experiments for meafuring the quantity of latent or combined heat in elaftic vapours. This is evidently a very important point to the diftiller and practical chemift. This heat muft all come from the fuel; and it is greatly worth while to know whether any faving may be made of this article. Thus we know that diftillation will go on either under the preffure of the air, or in an alembic and receiver from which the air has been expelled by fteam; and we know that this laft may be conducted in a very low temperature, even not exceeding that of the human body. But it is uncertain whether this may not employ even a greater quantity of fuel, as well as occafion a great expence of time. We are difpofed to think, that when there is no air in the apparatus, and when the condenfation can be fpeedily performed, the proportion of fuel expended to the fluid which comes over will diminifh continually as the heat, and confequently the denfity of the fteam, is augmented; becaufe in this cafe the quantity of combined heat muft be lefs. In the mean time, we earneftly recommend the trial of this mode of diftillation in veffels cleared of air. It is undoubtedly of great advantage to be able to work with fmaller fires; and it would fecure us againft all accidents of blowing off the

Steam. the head of the still, often attended with terrible consequences (B).

We must not conclude this article without taking notice of some natural phenomena which seem to owe their origin to the action of elastic steam.

We have already taken notice of the resemblance of the tremor and succussions observed in the shocks of many earthquakes to those which may be felt in a vessel where water is made to boil internally, while the breaking out of the ebullition is stifled by the cold of the upper parts; and we have likewise stated the objections which are usually made to this theory of earthquakes. We may perhaps resume the subject under the article VOLCANO; but in the mean time we do not hesitate to say, that the wonderful appearances of the Geyzer spring in Iceland (see HUER; and ICELAND, N° 3—5.) are undoubtedly produced by the expansion of steam in ignited caverns. Of these appearances we suppose the whole train to be produced as follows.

30 Explanation of the phenomena of the Geyzer spring in Iceland by the force of steam. Fig. 5.

A cavern may be supposed of a shape analogous to CBDEF (fig. 5.), having a perpendicular funnel AB issuing from a depressed part of the roof. The part F may be lower than the rest, remote, and red-hot. Such places we know to be frequent in Iceland. Water may be continually trickling into the part CD. It will fill it up to B, and even up to E *e*, and then trickle slowly along into F. As soon as any gets into contact with an ignited part, it expands into elastic steam, and is partly condensed by the cold sides of the cavern, which it gradually warms, till it condenses no more. This production of steam hinders not in the smallest degree the trickling of more water into F, and the continual production of more steam. This now presses on the surface of the water in CD, and causes it to rise gradually in the funnel BA; but slowly, because its cold surface is condensing an immense quantity of steam. We may easily suppose that the water trickles faster into F than it is expended in the production of steam; so that it reaches farther into the ignited part, and may even fall in a stream into some deeper pit highly ignited. It will now produce steam in vast abundance, and of prodigious elasticity; and at once push up the water through the funnel in a solid jet, and to a great height. This must continue till the surface of the water sinks to BD. If the lower end of the funnel have any inequalities or notches, as is most likely, the steam will get admission along with the water, which in this particular place is boiling hot, being superficial, and will get to the mouth of the funnel, while water is still pressed in below. At last the steam gets in at B on all sides; and as it is converging to B, along the surface of the water, with prodigious velocity it sweeps along with it much water, and blows it up through the funnel with great force. When this is over, the remaining steam blows out unmixed with water, growing weaker as it is expended, till the bottom of the funnel is again stopped by the water increasing in the cavern CBD. All the phenomena above ground are perfectly conformable to the necessary consequences of this very probable construction of the cavern. The feeling of being lifted up, immediately before the jet, in all probability is owing to a real heaving up of the whole roof of the cavern by the first expansion of the great body of steam. We had an accurate description of the phenomena from persons well qualified to judge of these matters who visited these celebrated springs in 1789.

STEAM-Engine, is the name of a machine which derives its moving power from the elasticity and condensibility of the steam of boiling water. It is the most valuable present which the arts of life have ever received from the philosopher. The mariner's compass, the telescope, gunpowder, and other most useful servants to human weakness and ingenuity, were the productions of chance, and we do not exactly know to whom we are indebted for them; but the steam-engine was, in the very beginning, the result of reflection, and the production of a very ingenious mind; and every improvement it has received, and every alteration in its construction and principles, were also the results of philosophical study.

1 Steam engine invented by the marquis of Worcester.

The steam-engine was beyond all doubt invented by the marquis of Worcester during the reign of Charles II. This nobleman published in 1663 a small book entitled A CENTURY OF INVENTIONS; giving some obscure and enigmatical account of an hundred discoveries or contrivances of his own, which he extols as of great importance to the public. He appears to have been a person of much knowledge and great ingenuity: but his description or accounts of these inventions seem not so much intended to instruct the public, as to raise wonder; and his encomiums on their utility and importance

(B) We earnestly recommend this subject to the consideration of the philosopher. The laws which regulate the formation of elastic vapour, or the general phenomena which it exhibits, give us that link which connects chemistry with mechanical philosophy. Here we see chemical affinities and mechanical forces set in immediate opposition to each other, and the one made the indication, characteristic, and measure of the other. We have not the least doubt that they make but one science, the Science of Universal Mechanics; nor do we despair of seeing the phenomena of solution, precipitation, crystallization, fermentation, nay animal and vegetable secretion and assimilation, successfully investigated, as cases of local motion, and explained by the agency of central forces. Some thing of this kind, and that not inconsiderable, was done when Dr Cullen first showed how the double affinities might be illustrated by the assistance of numbers. Dr Black gave to this hint (for it was little more) that elegant precision which characterizes all his views. Mr Kirwan has greatly promoted this study by his numerous and ingenious examples of its application; and the most valuable passages of the writings of Mr Lavoisier, are those where he traces with logical precision the balancings of force which appear in the chemical phenomena. It is from the similar balancings and consequent measurements, which may be observed and obtained in the present case, that we are to hope for admission into this almost unbounded science of contemplation. We have another link equally interesting and promising, viz. the production of heat by friction. This also highly deserves the consideration of the mathematical philosopher.

Steam-Engine.

ance are to a great degree extravagant, resembling more the puff of an advertising tradesman than the patriotic communications of a gentleman. The marquis of Worcester was indeed a projector, and very importunate and mysterious withal in his applications for public encouragement. His account, however, of the steam-engine, although by no means fit to give us any distinct notions of its structure and operation, is exact as far as it goes, agreeing precisely with what we now know of the subject. It is N° 68. of his inventions. His words are as follow: "This admirable method which I propose of raising water by the force of fire has no bounds if the vessels be strong enough: for I have taken a cannon, and having filled it three-fourths full of water, and shut up its muzzle and touch-hole, and exposed it to the fire for 24 hours, it burst with a great explosion. Having afterwards discovered a method of fortifying vessels internally, and combined them in such a way that they filled and acted alternately, I have made the water spout in an uninterrupted stream 40 feet high; and one vessel of rarefied water raised 40 of cold water. The person who conducted the operation had nothing to do but turn two cocks; so that one vessel of water being consumed, another begins to force, and then to fill itself with cold water, and so on in succession."

2
But first reduced to practice by Captain Savary.

It does not appear that the noble inventor could ever interest the public by these accounts. His character as a projector, and the many failures which persons of this turn of mind daily experience, probably prejudiced people against him, and prevented all attention to his projects. It was not till towards the end of the century, when experimental philosophy was prosecuted all over Europe with uncommon ardour, that these notions again engaged attention. Captain Savary, a person also of great ingenuity and ardent mind, saw the reality and practicability of the marquis of Worcester's project. He knew the great expansive power of steam, and had discovered the inconceivable rapidity with which it is reconverted into water by cold; and he soon contrived a machine for raising water, in which both of these properties were employed. He says, that it was entirely his own invention. Dr Desaguiliers insists that he only copied the marquis's invention, and charges him with gross plagiarism, and with having bought up and burned the copies of the marquis's book, in order to secure the honour of the discovery to himself. This is a very grievous charge, and should have been substantiated by very distinct evidence. Desaguiliers produces none such; and he was much too late to know what happened at that time. The argument which he gives is a very foolish one, and gave him no title to consider Savary's experiment as a falsehood; for it might have happened precisely as Savary relates, and not as it happened to Desaguiliers. The fact is, that Savary obtained his patent of invention after a hearing of objections, among which the discovery of the marquis of Worcester was not mentioned: and it is certain that the account given in the Century of Inventions could instruct no person who was not sufficiently acquainted with the properties of steam to be able to invent the machine himself.

3
Papin has no claim to the invention as the French pretend.

Captain Savary obtained his patent *after having actually erected* several machines, of which he gave a description in a book intitled THE MINER'S FRIEND, published in 1696, and in another work published in 1699. Much about this time Dr Papin, a Frenchman and fellow of the Royal Society, invented a method of dissolving bones and other animal solids in water, by confining them in close vessels, which he called DIGESTERS, so as to acquire a great degree of heat. For it must be observed in this place, that it had been discovered long before (in 1684) by Dr Hooke, the most inquisitive experimental philosopher of that inquisitive age, that water could not be made to acquire above a certain temperature in the open air; and that as soon as it begins to boil, its temperature remains fixed, and an increase of heat only produces a more violent ebullition, and a more rapid waste. But Papin's experiments made the elastic power of steam very familiar to him: and when he left England and settled as professor of mathematics at Marpurgh, he made many aukward attempts to employ this force in mechanics, and even for raising water. It appears that he had made experiments with this view in 1698, by order of Charles, landgrave of Hesse. For this reason the French affect to consider him as the inventor of the steam-engine. He indeed published some account of his invention in 1707; but he acknowledges that Captain Savary had also, and without any communication with him, invented the same thing. Whoever will take the trouble of looking at the description which he has given of these inventions, which are to be seen in the *Acta Eruditorum Lipsiæ*, and in Leupold's *Theatrum Machinarum*, will see that they are most aukward, absurd, and impracticable. His conceptions of natural operations were always vague and imperfect, and he was neither philosopher nor mechanician.

We are thus anxious about the claim of those gentlemen, because a most respectable French author, Mr Bossut, says in his *Hydrodynamique*, that the first notion of the steam-engine was *certainly* owing to Dr Papin, who had not only invented the digester, but had in 1695 published a little performance describing a machine for raising water, in which the pistons are moved by the vapour of boiling water alternately dilated and condensed. Now the fact is, that Papin's first publication was in 1707, and his piston is nothing more than a floater on the surface of the water, to prevent the waste of steam by condensation; and the return of the piston is not produced, as in the steam-engine, by the condensation of the steam, but by admitting the air and a column of water to press it back into its place. The whole contrivance is so aukward, and so unlike any distinct notions of the subject, that it cannot do credit to any person. We may add, that much about the same time Mr Amontons contrived a very ingenious but intricate machine, which he called a *fire-wheel*. It consisted of a number of buckets placed in the circumference of a wheel, and communicating with each other by very intricate circuitous passages. One part of this circumference was exposed to the heat of a furnace, and another to a stream or cistern of cold water. The communications were so disposed, that the steam produced in the buckets on one side of the wheel drove the water into buckets on the other side, so that one side of the wheel was always much heavier than the other; and it must therefore turn round, and may execute some work. The death of the inventor, and the intricacy of the machine, caused it to be neglected. Another member of the Parisian academy of sciences (Mr Deslandes) also presented to the academy a project of a steam-wheel, where the impulsive force of the vapour

4
Mr Amontons's fire-wheel.

pour was employed; but it met with no encouragement. The English engineers had by this time so much improved Savary's first invention, that it supplanted all others. We have therefore no hesitation in giving the honour of the first and complete invention to the marquis of Worcester; and we are not disposed to refuse Captain Savary's claim to originality as to the construction of the machine, and even think it probable that his own experiments made him see the whole, independent of the marquis's account.

Captain Savary's engine, as improved and simplified by himself, is as follows.

5
Captain Savary's steam-engine described.

Fig. 6.

A (fig. 6.) represents a strong copper boiler properly built up in a furnace. There proceeds from its top a large steam-pipe B, which enters into the top of another strong vessel R called the RECEIVER. This pipe has a cock at C called the STEAM-COCK. In the bottom of the receiver is a pipe F, which communicates sidewise with the rising pipe KGH. The lower end H of this pipe is immersed in the water of the pit or well, and its upper part K opens into the cistern into which the water is to be delivered. Immediately below the pipe of communication F there is a valve G, opening when pressed from below, and shutting when pressed downwards. A similar valve is placed at I, immediately above the pipe of communication. Lastly, there is a pipe ED which branches off from the rising pipe, and enters into the top of the receiver. This pipe has a cock D called the INJECTION-COCK. The mouth of the pipe ED has a nozzle f pierced with small holes, pointing from a centre in every direction. The keys of the two cocks C and D are united, and the handle $g\,h$ is called the REGULATOR.

Let the regulator be so placed that the steam-cock C is open and the injection-cock D is shut; put water into the boiler A, and make it boil strongly. The steam coming from it will enter the receiver, and gradually warm it, much steam being condensed in producing this effect. When it has been warmed so as to condense no more, the steam proceeds into the rising pipe; the valve G remains shut by its weight; the steam lifts the valve I, and gets into the rising pipe, and gradually warms it. When the workman feels this to be the case, or hears the rattling of the valve I, he immediately turns the steam-cock so as to shut it, the injection-cock still remaining shut (at least we may suppose this for the present.) The apparatus must now cool, and the steam in the receiver collapses into water. There is nothing now to balance the pressure of the atmosphere; the valve I remains shut by its weight; but the air incumbent on the water in the pit presses up this water through the suction-pipe HG, and causes it to lift the valve G, and flow into the receiver R, and fill it to the top, if not more than 20 or 25 feet above the surface of the pit water.

The steam-cock is now opened. The steam which, during the cooling of the receiver, has been accumulating in the boiler, and acquiring a great elasticity by the action of the fire, now rushes in with great violence, and, pressing on the surface of the water in the receiver, causes it to shut the valve G and open the valve I by its weight alone, and it now flows into the rising pipe, and would stand on a level if the elasticity of the steam were no more than what would balance the atmospherical pressure. But it is much more than this, and therefore it *presses* the water out of the receiver into the rising pipe, and will even cause it to come out at K, if the elasticity of the steam is sufficiently great. In order to ensure this, the boiler has another pipe in its top, covered with a *safety*-valve V, which is kept down by a weight W suspended on a steelyard LM. This weight is so adjusted that its pressure on the safety-valve is somewhat greater than the pressure of a column of water Vk as high as the point of discharge K. The fire is so regulated that the steam is always issuing a little by the loaded valve V. The workman keeps the steam-valve open till he hears the valve I rattle. This tells him that the water is all forced out of the receiver, and that the steam is now following it. He immediately turns the regulator which shuts the steam-cock, and now, for the first time, opens the injection-cock. The cold water trickles at first through the holes of the nozzle f, and falling down through the steam, begins to condense it; and then its elasticity being less than the pressure of the water in the pipe KEDf, the cold water spouts in all directions through the nozzle, and, quick as thought, produces a complete condensation. The valve G now opens again by the pressure of the atmosphere on the water of the pit, and the receiver is soon filled with cold water. The injection-cock is now shut, and the steam-cock opened, and the whole operation is now repeated; and so on continually.

This is the simple account of the process, and will serve to give the reader an introductory notion of the operation; but a more minute attention must be paid to many particulars before we can see the properties and defects of this ingenious machine.

6
Defects of this machine such,

The water is driven along the rising pipe by the elasticity of the steam. This must in the boiler, and every part of the machine, exert a pressure on every square inch of the vessels equal to that of the upright column of water. Suppose the water to be raised 100 feet, about 25 of this may be done in the suction-pipe; that is, the upper part of the receiver may be about 25 feet above the surface of the pit-water. The remaining 75 must be done by forcing, and every square inch of the boiler will be squeezed out by a pressure of more than 30 pounds. This very moderate height therefore requires very strong vessels; and the marquis of Worcester was well aware of the danger of their bursting. A copper boiler of six feet diameter must be nine-tenths of an inch thick to be just in equilibrio with this pressure: and the soldered joint will not be able to withstand it, especially in the high temperature to which the water must be heated in order to produce steam of sufficient elasticity. By consulting the table of the elasticity of steam deduced from our experiments mentioned in the preceding article, we see that this temperature must be at least 280° of Fahrenheit's thermometer. In this heat soft solder is just ready to melt, and has no tenacity; even spelter solder is considerably weakened by it. Accordingly, in a machine erected by Dr Desaguiliers, the workman having loaded the safety-valve a little more than usual to make the engine work more briskly, the boiler burst with a dreadful explosion, and blew up the furnace and adjoining parts of the building as if it had been gunpowder. Mr Savary succeeded pretty well in raising moderate quantities of water to small heights, but could make nothing of deep mines. Many attempts were made, on the marquis's

Steam-Engine.

quis's principle, to ſtrengthen the veſſels from within by radiated bars and by hoops, but in vain. Very ſmall boilers or evaporators were then tried, kept red hot, or nearly ſo, and ſupplied with a ſlender ſtream of water trickling into them; but this afforded no opportunity of making a collection of ſteam during the refrigeration of the receiver, ſo as to have a magazine of ſteam in readineſs for the next forcing operation; and the working of ſuch machines was always an employment of great danger and anxiety.

7
That it can be employed with advantage only in certain ſituations.

The only ſituation in which this machine could be employed with perfect ſafety, and with ſome effect, was where the whole lift did not exceed 30 or 35 feet. In this caſe the greateſt part of it was performed by the ſuction-pipe, and a very manageable preſſure was ſufficient for the reſt. Several machines of this kind were erected in England about the beginning of this century. A very large one was erected at a ſalt-work in the ſouth of France. Here the water was to be raiſed no more than 18 feet. The receiver was capacious, and it was occaſionally ſupplied with ſteam from a ſmall ſalt-pan conſtructed on purpoſe with a cover. The entry of the ſteam into the receiver merely allowed the water to run out of it by a large valve, which was opened by the hand, and the condenſation was produced by the help of a ſmall forcing pump alſo worked by the hand. In ſo particular a ſituation as this (and many ſuch may occur in the endleſs variety of human wants), this is a very powerful engine; and having few moving and rubbing parts, it muſt be of great durability. This circumſtance has occaſioned much attention to be given to this firſt form of the engine, even long after it was ſupplanted by thoſe of a much better conſtruction. A very ingenious attempt was made very lately to adapt this conſtruction to the uſes of the miners. The whole depth of the pit was divided into lifts of 15 feet, in the ſame manner as is frequently done in pump-machines. In each of theſe was a ſuction-pipe 14 feet long, having above it a ſmall receiver like R, about a foot high, and its capacity ſomewhat greater than that of the pipe. This receiver had a valve at the head of the ſuction-pipe, and another opening outwards into the little ciſtern, into which the next ſuction-pipe above dipped to take in water. Each of theſe receivers ſent up a pipe from its top, which all met in the cover of a large veſſel above ground, which was of double the capacity of all the receivers and pipes. This veſſel was cloſe on all ſides. Another veſſel of equal capacity was placed immediately above it, with a pipe from its bottom paſſing through the cover of the lower veſſel and reaching near to its bottom. This upper veſſel communicates with the boiler, and conſtitutes the receiver of the ſteam-engine. The operation is as follows: The lower veſſel is full of water. Steam is admitted into the upper veſſel, which expels the air by a valve, and fills the veſſel. It is then condenſed by cold water. The preſſure of the atmoſphere would cauſe it to enter by all the ſuction-pipes of the different lifts, and preſs on the ſurface of the water in the lower receiver, and force it into the upper one. But becauſe each ſuction-pipe dips in a ciſtern of water, the air preſſes this water before it, raiſes it into each of the little receivers which it fills, and allows the ſpring of the air (which was formerly in them, but which now paſſes up into the lower receiver) to force the water out of the lower receiver into the upper one. When this has been completed, the ſteam is again admitted into the upper receiver. This allows the water to run back into the lower receiver, and the air returns into the ſmall receivers in the pit, and allows the water to run out of each into its proper ciſtern. By this means the water of each pipe has been raiſed 15 feet. The operation may thus be repeated continually.

The contrivance is ingenious, and ſimilar to thoſe which are to be met with in the hydraulics of Schottus, Sturmius, and other German writers. But the operation muſt be exceedingly ſlow; and we imagine that the expence of ſteam muſt be great, becauſe it muſt fill a very large and very cold veſſel, which muſt waſte a great portion of it by condenſation. We ſee by ſome late publications of the very ingenious Mr Blackey, that he is ſtill attempting to maintain the reputation of this machine by ſome contrivances of this kind; but we imagine that they will be ineffectual, except in ſome very particular ſituations.

8
Occaſions great waſte of ſteam and fuel.

For the great defect of the machine, even when we can ſecure it againſt all riſk of burſting, is the prodigious waſte of ſteam, and conſequently of fuel. Daily experience ſhows, that a few ſcattered drops of cold water are ſufficient for producing an almoſt inſtantaneous condenſation of a great quantity of ſteam. Therefore when the ſteam is admitted into the receiver of Savary's engine, and comes into contact with the cold top and cold water, it is condenſed with great rapidity; and the water does not *begin* to ſubſide till its ſurface has become ſo hot that it condenſes no more ſteam. It may now begin to yield to the preſſure of the incumbent ſteam; but as ſoon as it deſcends a little, more of the cold ſurface of the receiver comes into contact with the ſteam, and condenſes more of it, and the water can deſcend no farther till this addition of cold ſurface is heated up to the ſtate of evaporation. This rapid condenſation goes on all the while the water is deſcending. By ſome experiments frequently repeated by the writer of this article, it appears that no leſs than $\frac{11}{12}$ths of the whole ſteam is uſeleſsly condenſed in this manner, and not more than $\frac{1}{12}$th is employed in allowing the water to deſcend by its own weight; and he has reaſon to think that the portion thus waſted will be conſiderably greater, if the ſteam be employed to *force* the water out of the receiver to any conſiderable height.

Obſerve, too, that all this waſte muſt be repeated in every ſucceeding ſtroke; for the whole receiver muſt be cooled again in order to fill itſelf with water.

9
The attempts made to diminiſh this waſte unſucceſsful.

Many attempts have been made to diminiſh this waſte; but all to little purpoſe, becauſe the very filling of the receiver with cold water occaſions its ſides to condenſe a prodigious quantity of ſteam in the ſucceeding ſtroke. Mr Blackey has attempted to leſſen this by uſing two receivers. In the firſt was oil; and into this only the ſteam was admitted. This oil paſſed to and fro between the two receivers, and never touched the water except in a ſmall ſurface. But this hardly produced a ſenſible diminution of the waſte: for it muſt now be obſerved, that there is a neceſſity for the firſt cylinder's being cooled to a conſiderable degree below the boiling point; otherwiſe, though it will condenſe much ſteam, and allow the water to riſe into the receiver, there will be a great diminution of the height of ſuction, unleſs the veſſel be much cooled. This appears plainly by by inſpecting the table of elaſticity. Thus, if the veſſel be cooled no lower than 180°, we ſhould loſe one half of the preſſure of the atmoſphere; if cooled to 120, we ſhould ſtill loſe $\frac{1}{10}$th. The inſpection of this table is of great uſe for underſtanding and improving this noble machine; and without a conſtant recollection of the elaſticity of ſteam correſponding to its actual heat, we ſhall never have a notion of the niceties of its operation.

10 The rapidity with which ſteam is condenſed.

The rapidity with which the ſteam is condenſed is really aſtoniſhing. Experiments have been made on ſteam-veſſels of ſix feet in diameter and ſeven feet high; and it has been found, that about four ounces of water, as warm as the human blood, will produce a complete condenſation in leſs than a ſecond; that is, will produce all the condenſation that it is capable of producing, leaving an elaſticity about one-fifth of the elaſticity of the air. In another experiment with the ſame ſteam-veſſel, no cold water was allowed to get into it, but it was made to communicate by a long pipe four inches in diameter with another veſſel immerſed in cold water. The condenſation was ſo rapid that the time could not be meaſured: it certainly did not exceed half a ſecond. Now this condenſation was performed by a very trifling ſurface of contact, Perhaps we may explain it a little in this way: When a maſs of ſteam, in immediate contact with the cold water, is condenſed, it leaves a void, into which the adjoining ſteam inſtantly expands; and by this very expanſion its capacity for heat is increaſed, or it grows cold, that is, abſtracts the heat from the ſteam ſituated immediately beyond it. And in this expanſion and refrigeration it is itſelf partly condenſed or converted into water, and leaves a void, into which the circumjacent ſteam immediately expands, and produces the ſame effect on the ſteam beyond it. And thus it may happen that the abſtraction of a ſmall quantity of heat from an inconſiderable maſs of ſteam may produce a condenſation which may be very extenſive. Did we know the change made in the capacity of ſteam for heat by a given change of bulk, we ſhould be able to tell exactly what would be the effect of this local actual condenſation. But experiment has not as yet given us any preciſe notions on this ſubject. We think that this rapid condenſation to a great diſtance by a very moderate actual abſtraction of heat is a proof that the capacity of ſteam for heat is prodigiouſly increaſed by expanſion. We ſay a *very moderate actual abſtraction* of heat, becauſe very little heat is neceſſary to raiſe four ounces of blood-warm water to a boiling temperature, which will unfit it for condenſing ſteam. The remarkable phenomenon of ſnow and ice produced in the Hungarian machine, when the air condenſed in the receiver is allowed to blow through the cock (ſee PNEUMATICS), ſhows this to be the caſe in moiſt air, that is, in air holding water in a ſtate of chemical ſolution. We ſee ſomething very like it in a thunder-ſtorm. A ſmall black cloud ſometimes appears in a particular ſpot, and in a very few ſeconds ſpreads over many hundred acres of ſky, that is, a precipitation of water goes on with that rapid diffuſion. We imagine that this increaſe of capacity or demand for heat, and the condenſation that muſt enſue if this demand is not ſupplied, is much more remarkable in pure watery vapours, and that this is a capital diſtinction of their conſtitution from vapours diſſolved in air (A).

The reader muſt now be ſo well acquainted with what paſſes in the ſteam-veſſel, and with the exterior reſults from it, as readily to comprehend the propriety of the changes which we ſhall now deſcribe as having been made in the conſtruction and principle of the ſteam engine. 11

Attempts to improve the ſteam-engine.

Of all places in England the tin-mines of Cornwall ſtood moſt in need of hydraulic aſſiſtance; and Mr Savary was much engaged in projects for draining them by his ſteam-engine. This made its conſtruction and principles well known among the machiniſts and engineers of that neighbourhood. Among theſe were a Mr Newcomen, an ironmonger or blackſmith, and Mr Cawley a glazier at Dartmouth in Devonſhire, who had dabbled much with this machine. Newcomen was a perſon of ſome reading, and was in particular acquainted with the perſon, writings, and projects of his countryman Dr Hooke. There are to be found among Hooke's papers, in the poſſeſſion of the Royal Society, ſome notes of obſervations, for the uſe of Newcomen his countryman, on Papin's boaſted method of tranſmitting to a great diſtance the action of a mill by means of pipes. Papin's project was to employ the mill to work two air-pumps of great diameter. The cylinders of theſe pumps were to communicate by means of pipes with equal cylinders furniſhed with piſtons, in the neighbourhood of a diſtant mine. Theſe piſtons were to be connected, by means of levers, with the piſton-rods of the mine. Therefore, when the piſton of the air-pump at the mill was drawn up by the mill, the correſponding piſton at the ſide of the mine would be preſſed down by the atmoſphere, and thus would raiſe the piſton-rod in the mine, and draw the water. It would appear from theſe notes, that Dr Hooke had diſſuaded Mr Newcomen from erecting a machine on this principle, of which he had expoſed the fallacy in ſeveral diſcourſes before the Royal Society. One paſſage is remarkable. "Could he (meaning Papin) make a ſpeedy vacuum under your ſecond piſton, your work is done."

It is highly probable that, in the courſe of this ſpeculation, it occurred to Mr Newcomen that the vacuum he ſo much wanted might be produced by ſteam, and that this gave riſe to his new principle and conſtruction of the ſteam-engine. The ſpecific deſideratum was in Newcomen's mind; and therefore, when Savary's engine appeared, and became known in his neighbourhood many years after, he would readily catch at the help which it promiſed.

Savary, however, claims the invention as his own; but Switzer, who was perſonally acquainted with both, is poſitive that Newcomen was the inventor. By his principles (as a quaker) being averſe from contention, he was contented to ſhare the honour and the profits with Savary, whoſe acquaintance at court enabled him to procure the patent in 1705, in which all the three were aſſociated. Poſterity has done juſtice to the modeſt inventor, and the machine is univerſally called NEWCOMEN'S

(A) But if it has been found that the condenſation requires more cold water than what is allowed above, and it is ſuſpected that the rapidity of condenſing a large volume of ſteam by the cold ſurface of a veſſel is overrated.

Steam-Engine.

12 Description of Newcomen's. Fig. 7.

MEN's ENGINE. Its principle and mode of operation may be clearly conceived as follows.

Let A (fig. 7.) represent a great boiler properly built in a furnace. At a small height above it is a cylinder CBBC of metal, bored very truly and smoothly. The boiler communicates with this cylinder by means of the throat or steam-pipe NQ. The lower aperture of this pipe is shut by the plate N, which is ground very flat, so as to apply very accurately to the whole circumference of the orifice. This plate is called the regulator or steam-cock, and it turns horizontally round an axis *b a* which passes through the top of the boiler, and is nicely fitted to the socket, like the key of a cock, by grinding. The upper end of this axis is furnished with a handle *b*T.

A piston P is suspended in this cylinder, and made air-tight by a packing of leather or soft rope, well filled with tallow; and, for greater security, a small quantity of water is kept above the piston. The piston-rod PD is suspended by a chain which is fixed to the upper extremity F of the arched head FD of the great lever or WORKING BEAM HK, which turns on the gudgeon O. There is a similar arched head EG at the other end of the beam. To its upper extremity E is fixed a chain carrying the pump-rod XL, which raises the water from the mine. The load on this end of the beam is made to exceed considerably the weight of the piston P at the other extremity.

At some small height above the top of the cylinder is a cistern W called the INJECTION CISTERN. From this descends the INJECTION PIPE ZSR, which enters the cylinder through its bottom, and terminates in a small hole R, or sometimes in a nozzle pierced with many smaller holes diverging from a centre in all directions. This pipe has at S a cock called the INJECTION COCK, fitted with a handle V.

At the opposite side of the cylinder, a little above its bottom, there is a lateral pipe, turning upwards at the extremity, and there covered by a clack-valve *f*, called the SNIFTING VALVE, which has a little dish round it to hold water for keeping it air-tight.

There proceeds also from the bottom of the cylinder a pipe *d e g h* (passing behind the boiler), of which the lower end is turned upwards, and is covered with a valve *h*. This part is immersed in a cistern of water Y, called the HOT WELL, and the pipe itself is called the EDUCTION PIPE. Lastly, the boiler is furnished with a safety-valve called the PUPPET CLACK (which is not represented in this sketch for want of room), in the same manner as Savary's engine. This valve is generally loaded with one or two pounds on the square inch, so that it allows the steam to escape when its elasticity is one-tenth greater than that of common air. Thus all risk of bursting the boiler is avoided, and the pressure outwards is very moderate; so also is the heat. For, by inspecting the table of vaporous elasticity, we see that the heat corresponding to 32 inches of elasticity is only about 216° of Fahrenheit's thermometer.

These are all the essential parts of the engine, and are here drawn in the most simple form, till our knowledge of their particular offices shall show the propriety of the peculiar forms which are given to them. Let us now see how the machine is put in motion, and what is the nature of its work.

13 How the machine is put in motion, and the nature of the work.

The water in the boiler being supposed to be in a state of strong ebullition, and the steam issuing by the safety-valve, let us consider the machine in a state of rest, having both the steam-cock and injection-cock shut. The resting position or attitude of the machine must be such as appears in sketch, the pump rods preponderating, and the great piston being drawn up to the top of the cylinder. Now open the steam-cock by turning the handle T of the regulator. The steam from the boiler will immediately rush in, and flying all over the cylinder, will mix with the air. Much of it will be condensed by the cold surface of the cylinder and piston, and the water produced from it will trickle down the sides, and run off by the eduction-pipe. This condensation and waste of steam will continue till the whole cylinder and piston are made as hot as boiling water. When this happens, the steam will begin to open the snifting valve *f*, and issue through the pipe; slowly at first and very cloudy, being mixed with much air. The blast at *f* will grow stronger by degrees, and more transparent, having already carried off the greatest part of the common air which filled the cylinder. We supposed that the water was boiling briskly, so that the steam was issuing by the safety-valve which is in the top of the boiler, and through every crevice. The opening of the steam-cock puts an end to this at once, and it has sometimes happened that the cold cylinder abstracts the steam from the boiler with such astonishing rapidity, that the pressure of the atmosphere has burst up the bottom of the boiler. We may here mention an accident of which we were witnesses, which also shows the the immense rapidity of the condensation. The boiler was in a frail shed at the side of the engine-house; a shoot of snow from the top of the house fell down and broke through the roof of the shed, and was scattered over the head of the boiler, which was of an oblong or oval shape. In an instant the sides of it were squeezed together by the pressure of the atmosphere.

When the manager of the engine perceives that not only the blast at the snifting valve is strong and steady, but that the boiler is now fully supplied with steam of a proper strength, appearing by the renewal of the discharge at the safety-valve, he shuts the steam-cock, and opens the injection-cock S by turning its handle V. The pressure of the column of water in the injection-pipe ZS immediately forces some water through the spout R. This coming in contact with the pure vapour which now fills the cylinder, condenses it, and thus makes a partial void, into which the more distant steam immediately expands, and by expanding collapses (as has been already observed). What remains in the cylinder no longer balances the atmospherical pressure on the surface of the water in the injection cistern, and therefore the water spouts rapidly through the hole R by the joint action of the column ZS, and the unbalanced pressure of the atmosphere; at the same time the snifting-valve *f*, and the eduction-valve *h*, are shut by the unbalanced pressure of the atmosphere. The velocity of the injection water must therefore rapidly increase, and the jet will dash (if single) against the bottom of the piston, and be scattered through the whole capacity of the cylinder. In a very short space of time, therefore, the condensation of the steam becomes universal, and the elasticity of what remains is almost nothing. The whole pressure preffure of the atmofphere is exerted in the upper furface of the pifton, while there is hardly any on its under fide. Therefore, if the load on the outer end E of the working beam is inferior to this preffure, it muft yield to it. The pifton P muft defcend, and the pump pifton L muft afcend, bringing along with it the water of the mine, and the motion muft continue till the great pifton reaches the bottom of the cylinder; for it is not like the motion which would take place in a cylinder of air rarefied to the fame degree. In this laft cafe, the impelling force would be continually diminifhed, becaufe the capacity of the cylinder is diminifhed by the defcent of the pifton, and the air in it is continually becoming more denfe and elaftic. The pifton would ftop at a certain height, where the elafticity of the included air, together with the load at E, would balance the atmofpheric preffure on the pifton. But when the contents of the cylinder are pure vapour, and the continued ftream of injected cold water keeps down its temperature to the fame pitch as at the beginning, the elafticity of the remaining fteam can never increafe by the defcent of the pifton, nor exceed what correfponds to this temperature. The impelling or accelerating force therefore remains the fame, and the defcent of the pifton will be uniformly accelerated, if there is not an increafe of refiftance arifing from the nature of the work performed by the other end of the beam. This circumftance will come under confideration afterwards, and we need not attend to it at prefent. It is enough for our prefent purpofe to fee, that if the cylinder has been completely purged of common air before the fteam-cock was fhut, and if none has entered fince, the pifton will defcend to the very bottom of the cylinder. And this may be frequently obferved in a good fteam-engine, where every part is air-tight. It fometimes happens, by the pit-pump drawing air, or fome part of the communication between the two ftrains giving way, that the pifton comes down with fuch violence as to knock out the bottom of the cylinder with the blow.

14 The pifton does not begin to defcend the moment the injection is made.

The only obfervation which remains to be made on the motion of the pifton in defcending is, that it does not begin at the inftant the injection is made. The pifton was kept at the top by the preponderancy of the outer end of the working beam, and it muft remain there till the difference between the elafticity of the fteam below it and the preffure of the atmofphere exceeds this preponderancy. There muft therefore be a fmall fpace of time between the beginning of the condenfation and the beginning of the motion. This is very fmall, not exceeding the third or the fourth part of a fecond; but it may be very diftinctly obferved by an attentive fpectator. He will fee, that the inftant the injection cock is opened, the cylinder will fenfibly rife upwards a little by the preffure of the air on its bottom. Its whole weight is not nearly equal to this preffure; and inftead of its being neceffary to *fupport* it by a ftrong floor, we muft *keep it down* by ftrong joifts loaded by heavy walls. It is ufual to frame thefe joints into the pofts which carry the axis of the working-beam, and are therefore loaded with the whole ftrain of the machine. This rifing of the cylinder fhows the inftantaneous commencement of the condenfation; and it is not till *after* this has been diftinctly obferved that the pifton is feen to ftart, and begin to defcend.

When the manager fees the pifton as low as he thinks proper, he fhuts the injection-cock, and opens the fteam-cock. The fteam has been accumulating above the water in the boiler during the whole time of the pifton's defcent, and is now rufhing violently through the puppet clack. The moment, therefore, that the fteam-cock is opened, it rufhes violently into the cylinder, having an elafticity greater than that of the air. It therefore immediately blows open the fnifting valve, and allows (at leaft) the water which had come in by the former injection, and what arofe from the condenfed fteam, to defcend by its own weight through the eduction pipe $d\,e\,g\,h$ to open the valve h, and to run out into the hot well. And we muft eafily fee that this water is boiling hot; for while lying in the bottom of the cylinder, it will condenfe fteam till it acquires this temperature, and therefore cannot run down till it condenfes no more. There is ftill a wafte of fteam at its firft admiffion, in order to heat the infide of the cylinder and the injected water to the boiling temperature: but the fpace being fmall, and the whole being already very warm, this is very foon done; and when things are properly conftructed, little more fteam is wanted than what will warm the cylinder; for the eduction pipe receives the injection water even during the defcent of the pifton, and it is therefore removed pretty much out of the way of the fteam.

15 The circumftances that fucceed the defcent of the pifton.

16 Effects of the firft puff of entering fteam

This firft puff of the entering fteam is of great fervice; it drives out of the cylinder the vapour which it finds there. This is feldom pure watery vapour: all water contains a quantity of air in a ftate of chemical union. The union is but feeble, and a boiling heat is fufficient for difengaging the greateft part of it by increafing its elafticity. It may alfo be difengaged by fimply removing the external preffure of the atmofphere. This is clearly feen when we expofe a glafs of water in an exhaufted receiver. Therefore the fmall fpace below the pifton contains watery vapour mixed with all the air which had been difengaged from the water in the boiler by ebullition, and all that was feparated from the injection water by the diminution of external preffures. All this is blown out of the cylinder by the firft puff of fteam. We may obferve in this place, that waters differ exceedingly in the quantity of air which they hold in a ftate of folution. All fpring water contains much of it: and water newly brought up from deep mines contains a great deal more, becaufe the folution was aided in thefe fituations by great preffures. Such waters fparkle when poured into a glafs. It is therefore of great confequence to the good performance of a fteam-engine to ufe water containing little air, both in the boiler and in the injection-ciftern. The water of running brooks is preferable to all others, and the freer it is from any faline impregnation it generally contains lefs air. Such engines as are fo unfortunately fituated that they are obliged to employ the very water which they have brought up from great depths, are found greatly inferior in their performance to others. The air collected below the pifton greatly diminifhes the accelerating force, and the expulfion of fuch a quantity requires a long-continued blaft of the beft fteam at the beginning of every ftroke. It is advifable to keep fuch water in a large fhallow pond for a long while before ufing it.

17 Of great confequence to the good performance of a fteam-engine, that the water employed contain little air.

18 How the pifton rifes.

Let us now confider the ftate of the pifton. It is evident that it will ftart or begin to rife the moment the

the ſteam-cock is opened; for at that inſtant the exceſs of atmoſpherical preſſure, by which it was kept down in oppoſition to the preponderancy of the outer end of the beam, is diminiſhed. The piſton is therefore *dragged* upwards, and it will riſe even although the ſteam which is admitted be not ſo elaſtic as common air. Suppoſe the mercury in the barometer to ſtand at 30 inches, and that the preponderancy at the outer end of the beam is $\frac{1}{9}$th of the preſſure of the air on the piſton, the piſton will not riſe if the elaſticity of the ſteam is not equal to $30-\frac{30}{9}$°, that is, to 26.7 inches nearly; but if it is juſt this quantity, the piſton will riſe as faſt as this ſteam can be ſupplied through the ſteam-pipe, and the velocity of its aſcent depends entirely on the velocity of this ſupply. This obſervation is of great importance; and it does not ſeem to have occurred to the mathematicians, who have paid moſt attention to the mechaniſm of the motion of this engine. In the mean time, we may clearly ſee that the entry of the ſteam depends chiefly on the counter weight at E: for ſuppoſe there was none, ſteam no ſtronger than air would not enter the cylinder at all; and if the ſteam be ſtronger, it will enter only by the exceſs of its ſtrength. Writers on the ſteam-engine (and even ſome of great reputation) familiarly ſpeak of the ſteam giving the piſton a puſh: But this is ſcarcely poſſible. During the riſe of the piſton the ſnifting valve is never obſerved to blow; and we have not heard any well-atteſted accounts of the piſton-chains ever being ſlackened by the upward preſſure of the ſteam, even at the very beginning of the ſtroke. During the riſing of the piſton the ſteam is (according to the common conception and manner of ſpeaking) *ſucked in*, in the ſame way that air is ſucked into a common ſyringe or pump when we draw up the piſton; for in the ſteam-engine the piſton is really drawn up by the counter weight. But it is ſtill more ſucked in, and requires a more copious ſupply, for another reaſon. As the piſton deſcended only in conſequence of the inſide of the cylinder's being ſufficiently cooled to condenſe the ſteam, this cooled ſurface muſt again be preſented to the ſteam during the riſe of the piſton, and muſt condenſe ſteam a ſecond time. The piſton cannot riſe another inch till the part of the cylinder which the piſton has already quitted has been warmed up to the boiling point, and ſteam muſt be expended in this warming. The inner ſurface of the cylinder is not only of the heat of boiling water while the piſton riſes, but is alſo perfectly dry; for the film of water left on it by the aſcending piſton muſt be completely evaporated, otherwiſe it will be condenſing ſteam. That the quantity thus waſted is conſiderable, appears by the experiments of Mr Beighton. He found that five pints of water were boiled off in a minute, and produced 16 ſtrokes of an engine whoſe cylinder contained 113 gallons of 282 inches each; and he thence concluded that ſteam was 2886 times rarer than water. But in no experiment made with ſcrupulous care on the expanſion of boiling water does it appear that the denſity of ſteam exceeds $\frac{1}{10,000}$th of the denſity of water. Deſaguiliers ſays that it is above 14,000 times rarer than water. We have frequently attempted to meaſure the weight of ſteam which filled a very light veſſel, which held 12,600 grains of water, and found it always leſs than one grain; ſo that we have no doubt of its being much more than 10,000 times rarer than water. This being the caſe, we may ſafely ſuppoſe that the number of gallons of ſteam, inſtead of being 16 times 113, were nearly five times as much; and that only $\frac{1}{5}$th was employed in allowing the piſton to riſe, and the remaining $\frac{4}{5}$ths were employed to warm the cylinder. But no diſtinct experiment ſhews ſo great an expanſion of water when converted into ſteam at 212°. Mr Watt never found it under the preſſure of the air more than 1800 times rarer than water.

19 Its aſcent chiefly owing to the weight of the pit piſton-rods.

The moving force during the aſcent of the piſton muſt be conſidered as reſulting chiefly, if not ſolely, from the preponderating weight of the pit piſton-rods. The office of this is to return the ſteam-piſton to the top of the cylinder, where it may again be preſſed down by the air, and make another working ſtroke by raiſing the pump rods. But the counter-weight at E has another ſervice to perform in this uſe of the engine; namely, to return the pump piſtons into their places at the bottom of their reſpective working barrels, in order that they alſo may make a working ſtroke. This requires force independent of the friction and inertia of the moving parts; for each piſton muſt be puſhed down through the water in the barrel, which muſt riſe through the piſton with a velocity whoſe proportion to the velocity of the piſton is the ſame with that of the bulk of the piſton to the bulk of the perforation through which the water riſes through the piſton. It is enough at preſent to mention this in general terms: we ſhall conſider it more particularly afterwards, when we come to calculate the performance of the engine, and to deduce from our acquired knowledge maxims of conſtruction and improvement.

20 The aſcent of the piſton differs greatly from the deſcent.

From this general conſideration of the aſcent of the piſton, we may ſee that the motion differs greatly from the deſcent. It can hardly be ſuppoſed to accelerate, even if the ſteam in the cylinder were in a moment annihilated. For the reſiſtance to the deſcent of the piſton is the ſame with the weight of the column of water, which would cauſe it to flow through the box of the pump piſton with the velocity with which it really riſes through it, and muſt therefore increaſe as the ſquare of that velocity increaſes; that is, as the ſquare of the velocity of the piſton increaſes. Independent of friction, therefore, the velocity of deſcent through the water muſt ſoon become a maximum, and the motion become uniform. We ſhall ſee by and by, that in ſuch a pump as is generally uſed this will happen in leſs than the 10th part of a ſecond. The friction of the pump will diminiſh this velocity a little, and retard the time of its attaining uniformity. But, on the other hand, the ſupply of ſteam which is neceſſary for this motion, being ſuſceptible of no acceleration from its previous motion, and depending entirely on the briſkneſs of the ebullition, an almoſt inſtantaneous ſtop is put to acceleration.

Accordingly, any perſon who obſerves with attention the working of a ſteam-engine, will ſee that the riſe of the piſton and deſcent of the pump-rods is extremely uniform, whereas the working ſtroke is very ſenſibly accelerated. Before quitting this part of the ſubject, and leſt it ſhould afterwards eſcape our recollection, we may obſerve, that the counter-weight is different during the two motions of the pump-rods. While the machine is making a working ſtroke, it is lifting not only the column

21 The counter-weight is different during the two motions of the pump rods.

lumn of water in the pump, but the abfolute weight of the piftons and pifton-rods alfo: but while the pump-rods are defcending, there is a diminution of the counter-weight by the whole weight loft by the immerfion of the rod in water. The wooden rods which are generally ufed, foaked in water, and joined by iron ftraps, are heavier, and but a little heavier, than water, and they are generally about one-third of the bulk of the water in the pumps.

Thefe two motions complete the period of the operation; and the whole may be repeated by fhutting the fteam-cock and opening the injection-cock whenever the pifton has attained the proper height. We have been very minute in our attention to the different circumftances, that the reader may have a diftinct notion of the ftate of the moving forces in every period of the operation. It is by no means fufficient that we know in general that the injection of cold water makes a void which allows the air to prefs down the pifton, and that the readmiffion of the fteam allows the pifton to rife again. This lumping and flovenly way of viewing it has long prevented even the philofopher from feeing the defects of the conftruction, and the methods of removing them.

22 Difference between Savary's and Newcomen's machines.

We now fee the great difference between Savary's and Newcomen's engine in refpect of principle. Savary's was really an engine which raifed water by the force of fteam; but Newcomen's raifes water entirely by the preffure of the atmofphere, and fteam is employed merely as the moft expeditious method of producing a void; into which the atmofpherical preffure may impel the *firft mover* of his machine. The elafticity of the fteam is not the firft mover.

23 Superiority of Newcomen's.

We fee alfo the great fuperiority of this new machine. We have no need of fteam of great and dangerous elafticity; and we operate by means of very moderate heats, and confequently with much fmaller quantities of fuel; and there is no bounds to the power of this machine. How deep foever a mine may be, a cylinder may be employed of fuch dimenfions that the preffure of the air on its pifton may exceed in any degree the weight of the column of water to be raifed. And laftly, this form of the machine renders it applicable to almoft every mechanical purpofe; becaufe a fkilful mechanic can readily find a method of converting the reciprocating motion of the working beam into a motion of any kind which may fuit his purpofe. Savary's engine could hardly admit of fuch an immediate application, and feems almoft reftricted to raifing water.

24 Gradually improved

Inventions improve by degrees. This engine was firft offered to the public in 1705. But many difficulties occurred in the execution, which were removed one by one; and it was not till 1712 that the engine feemed to give confidence in its efficacy. The moft exact and unremitting attention of the manager was required to the precife moment of opening and fhutting the cocks; and neglect might frequently be ruinous, by beating out the bottom of the cylinder, or allowing the pifton to be wholly drawn out of it. Stops were contrived to prevent both of thefe accidents; then ftrings were ufed to connect the handles of the cocks with the beam, fo that they fhould be turned whenever it was in

25 and fimplified.

certain pofitions. Thefe were gradually changed and improved into detents and catches of different fhapes; at laft, in 1717, Mr Beighton, a very ingenious and well-informed artift, fimplified the whole of thefe fubordinate movements, and brought the machine into the form in which it has continued, without the fmalleft material change, to the prefent day. We fhall now defcribe one of thefe improved engines, copying almoft exactly the drawings and defcription given by Boffut in his *Hydrodynamique*; thefe being by far the moft accurate and perfpicuous of any that have been publifhed.

26 Defcription of Beighton's fteam-engine. Plate DII. Fig. 8.

Fig. 8. N° 1. is a perfpective view of the boiler cylinder, and all the parts neceffary for turning the cocks. Fig. 8. N° 2. is a vertical fection of the fame; and the fame pieces of both are marked with the fame letters of reference.

The rod X of the pifton P is fufpended from the arch of the working beam, as was reprefented in the preceding fketch (fig. 7.). An upright bar of timber FG is alfo feen hanging by a chain. This is fufpended from a concentric arch of the beam, as may be feen alfo in the fketch at $\varphi\ \delta$. The bar is called the *plug-beam*; and it muft rife and fall with the pifton, but with a flower motion. The ufe of this plug-beam is to give motion to the different pieces which turn the cocks.

The fteam-pipe K is of one piece with the bottom of the cylinder, and rifes within it an inch or two, to prevent any of the cold injection water from falling into the boiler. The lower extremity Z of the fteam-pipe penetrates the head of the boiler, projecting a little way. A flat plate of brafs, in fhape refembling a racket or battledore, called the *regulator*, applies itfelf exactly to the whole circumference of the fteam-pipe, and completely excludes the fteam from the cylinder. Being moveable round an upright axis, which is reprefented by the dotted lines at the fide of the fteam-pipe in the profile, it may be turned afide by the handle *i*, n° 1. The profile fhows in the fection of this plate a protuberance in the middle. This refts on a ftrong flat fpring, which is fixed below it athwart the mouth of the fteam-pipe. This fpring preffes it ftrongly towards the fteam-pipe, caufing it to apply very clofe; and this knob flides along the fpring, while the regulator turns to the right or left.

We have faid that the injection-water is furnifhed from a ciftern placed above the cylinder. When the ciftern cannot be fupplied by pipes from fome more elevated fource, its water is raifed by the machine itfelf. A fmall lifting pump *i k* (fig. 7.), called the *jack-head* or *jaquette*, is worked by a rod $\gamma\ \iota$, fufpended from a concentric arch $\iota\ \gamma$ near the outer end of the working beam. This forces a fmall portion of the pit water along the rifing pipe *i* LM into the injection ciftern.

In figure 8. N° 1. and 2. the letters QM 3′ reprefent the pipe which brings down the water from the injection ciftern. This pipe has a cock at R to open or fhut the paffage of this water. It fpouts through the jet 3′, and dafhing againft the bottom of the pifton, it is difperfed into drops, and fcattered through the whole capacity of the cylinder, fo as to produce a rapid condenfation of the fteam.

An upright poft A may be obferved in the perfpective view of the cylinder, &c. This fupports one end B of a horizontal iron axis BC. The end C is fupported by a fimilar poft, of which the place only is marked by the dotted lines A, that the pieces connected

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ted with this axis may not be hid by it. A kind of ſtirrup *a b c d* hangs from this axis, ſupported by the hooks *a* and *d*. This ſtirrup is croſſed near the bottom by a round bolt or bar *e*, which paſſes through the eyes or rings that are at the ends of the horizontal fork *h f g*, whoſe long tail *h* is double, receiving between its branches the handle *i* of the regulator. It is plain from this conſtruction, that when the ſtirrup is made to vibrate round the horizontal axis BC, on which it hangs freely by its hooks, the bolt *e* muſt pull or puſh the long fork *h f g* backwards and forwards horizontally, and by ſo doing will move the regulator round its axis by means of the handle *i*. Both the tail of the fork and the handle of the regulator are pierced with ſeveral holes, and a pin is put through them which unites them by a joint. The motion of the handle may be increaſed or diminiſhed by chooſing for the joint a hole near to the axis or remote from it; and the exact poſition at which the regulator is to ſtop on both ſides is determined by pins ſtuck in the horizontal bar on which the end of the handle appears to reſt.

This alternate motion of the regulator to the right and left is produced as follows: There is fixed to the axis BC a piece of iron *o k l*, called the Y, on account of its reſemblance to that letter of the alphabet inverted. The ſtalk *o* carries a heavy lump *p* of lead or iron; and a long leather ſtrap *q p r* is faſtened to *p* by the middle, and the two ends are faſtened to the beam above it, in ſuch a manner that the lump may be alternately catched and held up to the right and left of the perpendicular. By adjuſting the length of the two parts of the ſtrap, the Y may be ſtopped in any deſired poſition. The two claws *k* and *l* ſpread out from each other, and from the line of the ſtalk, and they are of ſuch length as to reach the horizontal bolt *e*, which croſſes the ſtirrup below, but not to reach the bottom of the fork *h f g*. Now ſuppoſe the ſtirrup hanging perpendicularly, and the ſtalk of the Y alſo held perpendicular; carry it a little outward from the cylinder, and then let it go. It will tumble farther out by its weight, without affecting the ſtirrup till the claw *l* ſtrikes on the horizontal bolt *e*, and then it puſhes the ſtirrup and the fork towards the cylinder, and opens the regulator. It ſets it in motion with a ſmart jerk, which is an effectual way of overcoming the coheſion and friction of the regulator with the mouth of the ſteam-pipe. This puſh is adjuſted to a proper length by the ſtrap *q p*, which ſtops the Y when it has gone far enough. If we now take hold of the ſtalk of the Y, and move it up to the perpendicular, the width between its claws is ſuch as to permit this motion, and ſomething more, without affecting the ſtirrup. But when puſhed ſtill nearer to the cylinder, it tumbles towards it by its own weight, and then the claw *k* ſtrikes the bolt *e*, and drives the ſtirrup and fork in the oppoſite direction, till the lump *p* is catched by the ſtrap *rp*, now ſtretched to its full length, while *qp* hangs ſlack. Thus by the motion of the Y the regulator is opened and ſhut. Let us now ſee how the motion of the Y is produced by the machine itſelf. To the horizontal axis BC are attached two ſpanners or handles *m* and *n*. The ſpanner *m* paſſes through a long ſlit in the plug-beam, and is at liberty to move upwards or downwards by its motion round the axis BC. A pin *π* which goes through the plug-beam catches hold of *m* when the beam riſes along with the piſton; and the pin is ſo placed, that when the beam is within an inch or two of its higheſt riſe, the pin has lifted *m* and thrown the ſtalk of the Y paſt the perpendicular. It therefore tumbles over with great force, and gives a ſmart blow to the fork, and immediately ſhuts the regulator. By this motion the ſpanner *m* is removed out of the neighbourhood of the plug-beam. But the ſpanner *n*, moving along with it in the ſame direction, now comes into the way of the pins of the plug-beam. Therefore, when the piſton deſcends again by the condenſation of the ſteam in the cylinder, a pin marked *&* in the ſide of the plug-beam catches hold of the tail of the ſpanner *n*, and by preſſing it down raiſes the lump on the ſtalk of the Y till it paſſes the perpendicular, and it then falls down, outwards from the cylinder, and the claw *l* again drives the fork in the direction *h i*, and opens the ſteam valve. This opening and ſhutting of the ſteam valve is executed in the preciſe moment that is proper, by placing the pins *π* and *&* at a proper height of the plug-beam. For this reaſon, it is pierced through with a great number of holes, that the places of theſe pins may be varied at pleaſure. This, and a proper curvature of the ſpinners *m* and *n*, make the adjuſtment as nice as we pleaſe.

The injection cock R is managed in a ſimilar manner. On its key may be obſerved a forked arm *s t*, like a crab's claw; at a little diſtance above it is the gudgeon or axis *u* of a piece *y u z*, called the hammer or the F, from its reſemblance to that letter. It has a lump of metal *y* at one end, and a ſpear *u s* projects from its middle, and paſſes between the claws *s* and *t* of the arm of the injection-cock. The hammer *y* is held up by a notch in the under ſide of a wooden lever DE, moveable round the center D, and ſupported at a proper height by a ſtring *r* E, made faſt to the joiſt above it.

Suppoſe the injection-cock ſhut, and the hammer in the poſition repreſented in the figure. A pin *β* of the plug-frame riſes along with the piſton, and catching hold of the detent DE, raiſes it, and diſengages the hammer *y* from its notch. This immediately falls down, and ſtrikes a board L put in the way to ſtop it. The ſpear *u s* takes hold of the claw *t*, and forces it aſide towards *x*, and opens the injection-cock. The piſton immediately deſcends, and along with it the plug-frame. During its deſcent the pin *β* meets with the tail *u z* of the hammer, which is now raiſed conſiderably above the level, and brings it down along with it, raiſing the lump *y*, and gradually ſhutting the injection-cock, becauſe the ſpear takes hold of the claw *s* of its arm. When the beam has come to its loweſt ſituation, the hammer is again engaged in the notch of the detent DE, and ſupported by it till the piſton again reaches the top of the cylinder.

In this manner the motions of the injection cock are alſo adjuſted to the preciſe moment that is proper for them. The different pins are ſo placed in the plug-frame, that the ſteam-cock may be completely ſhut before the injection-cock is opened. The inherent motion of the machine will give a ſmall addition to the aſcent of the piſton without expending ſteam all the while; and by leaving the ſteam rather leſs elaſtic than before, the ſubſequent deſcent of the piſton is promoted. There was a conſiderable propriety in the gradual ſhut-

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ting of the injection-cock. For after the first dash of the cold water against the bottom of the piston, the condensation is nearly complete, and very little more water is needed; but a continual accession of some is absolutely necessary for completing the condensation, as the capacity of the cylinder diminishes, and the water warms which is already injected.

In this manner the motion of the machine will be repeated as long as there is a supply of steam from the boiler, and of water from the injection cistern, and a discharge procured for what has been injected. We proceed to consider how far these conditions also are provided by the machine itself.

The injection cistern is supplied with water by the jackhead pump, as we have already observed. From this source all the parts of the machine receive their respective supplies. In the first place, a small branch 13, 13, is taken off from the injection-pipe immediately below the cistern, and conducted to the top of the cylinder, where it is furnished with a cock. The spout is so adjusted, that no more runs from it than what will keep a constant supply of a foot of water above the piston to keep it tight. Every time the piston comes to the top of the cylinder, it brings this water along with it, and the surplus of its evaporation and leakage runs off by a waste-pipe 14, 14. This water necessarily becomes almost boiling hot, and it was thought proper to employ its overplus for supplying the waste of the boiler. This was accordingly practised for some time. But Mr Beighton improved this economical thought, by supplying the boiler from the eduction-pipe, 2, 2, the water of which must be still hotter than that above the piston. This contrivance required attention to many circumstances, which the reader will understand by considering the perspective and profile. The eduction-pipe comes out of the bottom of the cylinder at 1 with a perpendicular part, which bends sidewise below, and is shut at the extremity 1. A deep cup 5 communicates with it, holding a metal valve nicely fitted to it by grinding, like the key of a cock. To secure its being always air-tight, a slender stream of water trickles into it from a branch 6 of the waste-pipe from the top of the cylinder. The eduction pipe branches off at 2, and goes down to the hot well, where it turns up, and is covered with a valve. In the perspective view may be observed an upright pipe 4, 4, which goes through the head of the boiler, and reaches to within a few inches of its bottom. This pipe is called the *feeder*, and rises about three or four feet above the boiler. It is open at both ends, and has a branch 3, 3, communicating with the bottom of the cup 5, immediately above the metal valve, and also a few inches below the level of the entry 2 of the eduction-pipe. This communicating branch has a cock by which its passage may be diminished at pleasure. Now suppose the steam in the boiler to be very strong, it will cause the boiling water to rise in the feeding pipe above 3, and coming along this branch, to rise also in the cup 5, and run over. But the height of this cup above the surface of the water in the boiler is such, that the steam is never strong enough to produce this effect. Therefore, on the contrary, any water that may be in the cup 5 will run off by the branch 3, 3, and go down into the boiler by the feeding pipe.

These things being understood, let us suppose a quantity of injected water lying at the bottom of the cylinder. It will run into the eduction-pipe, fill the crooked branch 1, 1, and open the valve in the bottom of the cup (its weight being supported by a wire hanging from a slender spring), and it will fill the cup to the level of the entry 2 of the eduction-pipe, and will then flow along 3, 3, and supply the boiler by the feeder 4, 4. What more water runs in at 1 will now go along the eduction pipe 2, 2, to the hot well. By properly adjusting the cock on the branch 3, 3, the boiler may be supplied as fast as the waste in steam requires. This is a most ingenious contrivance, and does great honour to Mr Beighton. It is not, however, of much importance. The small quantity which the boiler requires may be immediately taken even from a cold cistern, without sensibly diminishing the production of steam: for the quantity of heat necessary for raising the sensible heat of cold water to the boiling temperature is small, when compared with the quantity of heat which must then be combined with it in order to convert the water into steam. For the heat expended in boiling off a cubic foot of water is about six times as much as would bring it to a boiling heat from the temperature of 55°. No difference can be observed in the performance of such engines, and of those which have their boilers supplied from a brook. It has, however, the advantage of being purged of air; and when an engine must derive all its supplies from pit water, the water from the eduction-pipe is vastly preferable to that from the top of the cylinder.

27 An ingenious contrivance.

We may here observe, that many writers (among them the Abbé Bossut), in their descriptions of the steam-engine, have drawn the branch of communication 3, 3, from the feeding-pipe to a part of the crooked pipe 1, 1, lying below the valve in the cup 5. But this is quite erroneous; for, in this case, when the injection is made into the cylinder, and a vacuum produced, the water from the boiler would immediately rush up through the pipes 4, 3, and spout up into the cylinder: so would the external air coming in at the top of the feeder.

28 Which enables us to form some judgement of the internal state of the engine during the performance.

This contrivance has also enabled us to form some judgement of the internal state of the engine during the performance. Mr Beighton paid a minute attention to the situation of the water in the feeders and eduction-pipe of an engine, which seems to have been one of the best which has yet been erected. It was lifting a column of water whose weight was four-sevenths of the pressure of the air on its piston, and made 16 strokes, of six feet each, in a minute. This is acknowledged by all to be a very great performance of an engine of this form. He concluded that the elasticity of the steam in the cylinder was never more than one-tenth greater or less than the elasticity of the air. The water in the feeder never rose more than three feet and a half above the surface of the boiling water, even though it was now lighter by $\frac{1}{27}$th than cold water. The eduction-pipe was only four feet and a half long (vertically), and yet it always discharged the injection water completely, and allowed some to pass into the feeder. This could not be if the steam was much more than one-tenth weaker than air. By grasping this pipe in his hand during the rise of the piston, he could guess very well whereabouts the surface of the hot water in it rested during the motion, and he never found it supported so high as four feet. Therefore the steam in the cylinder had at least eight-ninths of

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of the elafticity of the air. Mr Buat, in his examination of an engine which is erected at Montrelaix, in France, by an Englifh engineer, and has always been confidered as the pattern in that country, finds it neceffary to fuppofe a much greater variation in the ftrength of the fteam, and fays, that it muft have been one-fifth ftronger and one-fifth weaker than common air. But this engine has not been nearly fo perfect. Its lift was not more than one-half of the preffure of the atmofphere, and it made but nine ftrokes in a minute.—At W is a valve covering the mouth of a fmall pipe, and furrounded with a cup containing water to keep it air-tight. This allows the air to efcape which had been extricated from the water of laft injection. It is driven out by the firft ftrong puff of fteam which is admitted into the cylinder, and makes a noife in its exit. The valve is therefore called the fnifting-valve.

To finifh our defcription, we obferve, that befides the fafety valve 9 (called the PUPPET CLACK), which is loaded with about 3 pounds on the fquare inch (though the engine will work very well with a load of 1 or 2 pounds), there is another DISCHARGER 10,10, having a clack at its extremity fupported by a cord. Its ufe is to difcharge the fteam without doors, when the machine gives over working. There is alfo a pipe SI near the bottom of the boiler, by which it may be emptied when it needs repairs or cleanfing.

There are two fmall pipes 11,11, and 12,12, with cocks called GAGE-PIPES. The firft defcends to within two inches of the furface of the water in the boiler, and the fecond goes about 2 inches below that furface. If both cocks emit fteam, the water is too low, and requires a recruit. If neither give fteam, it is too high, and there is not fufficient room above it for a collection of fteam. Laftly, there is a filling pipe Q, by which the boiler may be filled when the machine is to be fet to work.

29 This form of the engine has been continued for many years, the only change being the pofition of the boiler.

The engine has continued in this form for many years. The only remarkable change introduced has been the manner of placing the boiler. It is no longer placed below the cylinder, but at one fide, and the fteam is introduced by a pipe from the top of the boiler into a flat box immediately below the cylinder. The ufe of this box is merely to lodge the regulator, and give room for its motions. This has been a very confiderable improvement. It has greatly reduced the height of the building. This was formerly a tower. The wall which fupported the beam could hardly be built with fufficient ftrength for withftanding the violent fhocks which were repeated without ceafing; and the buildings feldom lafted more than a very few years. But the boiler is now fet up in an adjoining fhed, and the gudgeons of the main beam reft on the top of upright pofts, which are framed into the joifts which fupport the cylinder. Thus the whole moving parts of the machine are contained in one compact frame of carpentry, and have little or no connection with the flight walls of the building, which is merely a cafe to hold the machine, and protect it from the weather.

30 How to afcertain the moft advantageous proportion between the moving power and the load.

It is now time to inquire what is to be expected from this machine, and to afcertain the moft advantageous proportion between the moving power and the load that is to be laid on the machine.

It may be confidered as a great pulley, and is indeed fometimes fo conftructed, the arches at the ends of the working beam being completed to a circle. It muft be unequally loaded that it may move. It is loaded, during the working ftroke, by the preffure of the atmofphere on the pifton fide, and by the column of water to be raifed and the pump-gear on the pump fide.—During the returning ftroke it is loaded, on the pifton fide, by a fmall part of the atmofpheric preffure, and on the pump fide by the pump gear acting as a counter weight. The load during the working ftroke muft therefore confift of the column of water to be raifed and this counter weight. The performance of the machine is to be meafured only by the quantity of water raifed in a given time to a given height. It varies, therefore, in the joint proportion of the weight of the column of water in the pumps, and the number of ftrokes made by the machine in a minute. Each ftroke confifts of two parts, which we have called the working and the returning ftroke. It does not, therefore, depend fimply on the velocity of the working ftroke and the quantity of water raifed by it. If this were all that is to be attended to, we know that the weight of the column of water fhould be nearly $\frac{2}{3}$ths of the preffure of the atmofphere, this being the proportion which gives the maximum in the common pulley. But the time of the returning ftroke is a neceffary part of the whole time elapfed, and therefore the velocity of the returning ftroke equally merits attention. This is regulated by the counter weight. The number of ftrokes per minute does not give an immediate proof of the goodnefs of the engine. A fmall load of water and a great counter weight will enfure this, becaufe thefe conditions will produce a brifk motion in both directions.—The proper adjuftment of the preffure of the atmofphere on the pifton, the column of water to be raifed, and the counter weight, is a problem of very great difficulty; and mathematicians have not turned much of their attention to the fubject, although it is certainly the moft interefting queftion that practical mechanics affords them.

31 Mr Boffut's folution,

Mr Boffut has folved it very fhortly and fimply, upon this fuppofition, that the working and returning ftroke fhould be made in equal times. This, indeed, is generally aimed at in the erection of thefe machines, and they are not reckoned to be well arranged if it be otherwife. We doubt of the propriety of the maxim. Suppofing, however, this condition for the prefent, we may compute the loadings of the two ends of the beam as follows. Let a be the length of the inner arm of the working beam, or that by which the great pifton is fupported. Let b be the outer arm carrying the pump rods, and let W be a weight equivalent to all the load which is laid on the machine. Let c^2 be the area of the pifton; let H be the height of a column of water having c^2 for its bafe, and being equal in weight to the preffure exerted by the fteam on the under fide of the pifton; and let h be the preffure of the atmofphere on the fame area, or the height of a column of water of equal weight. It is evident that both ftrokes will be performed in equal times, if $h\,c^2\,a - W\,b$ be equal to $(h - H)\,c^2\,a + W\,b$. The firft of thefe quantities is the energy of the machine during the working ftroke, and the fecond expreffes the fimilar energy during the returning ftroke. This equation gives us $W = \frac{2\,h\,c^2\,a - H\,c^2\,a}{2\,b} = \frac{(2\,h - H)\,c^2\,a}{2\,b}$. If we

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we suppose the arms of the lever equal and $H=h$, we have $W=c^2\frac{h}{2}$; that is, the whole weight of the outer end of the beam should be half the pressure of the air on the great piston. This is nearly the usual practice; and the engineers express it by saying, that the engine is loaded with seven or eight pounds on the square inch. This has been found to be nearly the most advantageous load. This way of expressing the matter would do well enough, if the maxim were not founded on erroneous notions, which hinder us from seeing the state of the machine, and the circumstances on which its improvement depends. The piston bears a pressure of 15 pounds, it is said, on the square inch, if the vacuum below it be perfect; but as this is far from being the case, we must not load it above the power of its vacuum, which very little exceeds eight pounds. But this is very far from the truth. When the cylinder is tight, the vacuum is not more than $\frac{1}{30}$th deficient, when the cylinder is cooled by the injection to the degree that is every day practicable, and the piston really bears during its descent a pressure very near to 14 pounds on the inch. The load must be diminished, not on account of the imperfect vacuum, but to give the machine a reasonable motion. We must consider not only the moving force, but also the quantity of matter to be put in motion. This is so great in the steam-engine, that even if it were balanced, that is, if there were suspended on the piston arm a weight equal to the whole column of water and the counter weight, the full pressure of the atmosphere on the steam piston would not make it move twice as fast as it does.

32 founded on an erroneous maxim,

33 and faulty in another respect.

This equation by Mr Bossut is moreover essentially faulty in another respect. The W in the first member is not the same with the W in the second. In the first it is the column of water to be raised, together with the counter weight. In the second it is the counter weight only. Nor is the quantity H the same in both cases, as is most evident. The proper equation for ensuring the equal duration of the two strokes may be had in the following manner. Let it be determined by experiment what portion of the atmospheric pressure is exerted on the great piston during its descent. This depends on the remaining elasticity of the steam. Suppose it $\frac{9}{10}$ths: this we may express by $a\,h$, a being $=\frac{9}{10}$ths. Let it also be determined by experiment what portion of the atmospheric pressure on the piston remains unbalanced by the steam below it during its ascent. Suppose this $\frac{1}{10}$th, we may express this by $b\,h$. Then let W be the weight of the column of water to be raised, and c the counter weight. Then, if the arms of the beam are equal, we have the energy during the working stroke $=a\,h-W-c$, and during the returning stroke it is $=c-b\,h$. Therefore $c-b\,h=a\,h-W-c$; and $c=\frac{h(a+b)-W}{2}$; which, on the above supposition of the values of a and b, gives us $c=\frac{h-W}{2}$. We shall make some use of this equation afterwards; but it affords us no information concerning the most advantageous proportion of h and W, which is the material point.

34 Another way of considering the matter.

We must consider this matter in another way: And that we may not involve ourselves in unnecessary difficulties, let us make the case as simple as possible, and suppose the arms of the working-beam to be of equal length.

We shall first consider the adjustment of things at the outer end of the beam.

35 Adjustment of things at the outer end of the beam considered.

Since the sole use of the steam is to give room for the action of the atmospheric pressure by its rapid condensibility, it is admitted into the cylinder only to allow the piston to rise again, but without giving it any impulse. The pump-rods must therefore be returned to the bottom of the working barrels by means of a preponderancy at the outer end of the beam. It may be the weight of the pump-rods themselves, or may be considered as making part of this weight. A weight at the end of the beam will not operate on the rods which are suspended there by chains, and it must therefore be attached to the rods themselves, but above their respective pump-barrels, so that it may not lose part of its efficacy by immersion in the water. We may consider the whole under the notion of the pump-gear, and call it p. Its office is to depress the pump-rods with sufficient velocity, by overcoming the resistances arising from the following causes.

1. From the inertia of the beams and all the parts of the apparatus which are in motion during the descent of the pump-rods.

2. From the loss of weight sustained by the immersion of the pump-rods in water.

3. From the friction of all the pistons and the weight of the plug-frame.

4. From the resistance to the piston's motion, arising from the velocity which must be generated in the water in passing through the descending pistons.

The sum of all these resistances is equal to the pressure of some weight (as yet unknown), which we may call m.

When the pump-rods are brought up again, they bring along with them a column of water, whose weight we may call w.

It is evident that the load which must be overcome by the pressure of the atmosphere on the steam piston consists of w and p. Let this load be called L, and the pressure of the air be called P.

If p be $=$ L, no water will be raised; if p be $=o$, the rods will not descend: therefore there is some intermediate value of p which will produce the greatest effect.

In order to discover this, let g be the fall of a heavy body in a second.

The descending mass is p: but it does not descend with its full weight; because it is overcoming a set of resistances which are equivalent to a weight m, and the moving force is $p-m$. In order to discover the space through which the rods will descend in a second, when urged by the force $p-m$ (supposed constant, notwithstanding the increase of velocity, and consequently of m), we must institute this proportion $p:p-m=g:\frac{g(p-m)}{p}$.

The fourth term of this analogy is the space required.

Let t be the whole time of the descent in seconds. Then $1^2:t^2=\frac{g(p-m)}{p}:\frac{t^2g(p-m)}{p}$. This last term is is the whole deſcent or length of the ſtroke accompliſhed in the time t.

The weight of the column of water, which has now got above the piſton, is w, $=\text{L}-p$. This muſt be lifted in the next working ſtroke through the ſpace $\frac{t^2 g(p-m)}{p}$. Therefore the performance of the engine muſt be $\frac{t^2 g(p-m)(\text{L}-p)}{p}$.

That this may be the greateſt poſſible, we muſt conſider p as the variable quantity, and make the fluxion of the fraction $\frac{\overline{p-m}\times\overline{\text{L}-p}}{p}=o$.

This will be found to give us $p=\sqrt{\text{L}\,m}$; that is, the counter weight or preponderancy of the outer end of the beam is $=\sqrt{\text{L}\,m}$.

This gives us a method of determining m experimentally. We can diſcover by actual meaſurement the quantity L in any engine, it being equal to the unbalanced weights on the beam and the weight of the water in the pumps. Then $m=\frac{p^2}{\text{L}}$.

Alſo we have the weight of the column of water $=\text{L}-p$, $=\text{L}-\sqrt{\text{L}\,m}$.

When therefore we have determined the load which is to be on the outer end of the beam during the working ſtroke, it muſt be diſtributed into two parts, which have the proportion of $\sqrt{\text{L}\,m}$ to $\text{L}-\sqrt{\text{L}\,m}$. The firſt is the counter weight, and the ſecond is the weight of the column of water.

If m is a fraction of L, ſuch as an aliquot part of it; that is, if

$$m=\frac{\text{L}}{1},\ \frac{\text{L}}{4},\ \frac{\text{L}}{9},\ \frac{\text{L}}{16},\ \frac{\text{L}}{25},\ \text{\&c.}$$
$$p=\frac{\text{L}}{1},\ \frac{\text{L}}{2},\ \frac{\text{L}}{3},\ \frac{\text{L}}{4},\ \frac{\text{L}}{5},\ \text{\&c.}$$

The circumſtance which is commonly obtruded on us by local conſiderations is the quantity of water, and the depth from which it is to be raiſed; that is, w: and it will be convenient to determine every thing in conformity to this.

We ſaw that $w=\text{L}-\sqrt{\text{L}\,m}$. This gives us $\text{L}=\pm\sqrt{wm+\frac{m^2}{4}}+\frac{m}{2}+w$, and the counter weight $p=\sqrt{w\,m+\frac{m^2}{4}}+\frac{m}{2}$.

36 What proportion of moving force may be applied to the greateſt advantage.

Having thus aſcertained that diſtribution of the load on the outer end of the beam which produces the greateſt effect, we come now to conſider what proportion of moving force we muſt apply, ſo that it may be employed to the beſt advantage, or ſo that any expence of power may produce the greateſt performance. It will be ſo much the greater as the work done is greater, and the power employed is leſs; and will therefore be properly meaſured by the quotient of the work done divided by the power employed.

The work immediately done is the lifting up the weight L. In order to accompliſh this, we muſt employ a preſſure P, which is greater than L. Let it be $=\text{L}+y$; alſo let s be the length of the ſtroke.

If the maſs L were urged along the ſpace s by the force $\text{L}+y$, it would acquire a certain velocity, which we may expreſs by $\sqrt{s}$; but it is impelled only by the force y, the reſt of P being employed in balancing L. The velocities which different forces generate by impelling a body along the ſame ſpace are as the ſquare roots of the forces. Therefore $\sqrt{\text{L}+y} : \sqrt{y} = \sqrt{s} : \frac{\sqrt{s\,y}}{\sqrt{\text{L}+y}}$. The fourth term of this analogy expreſſes the velocity of the piſton at the end of the ſtroke. The quantity of motion produced will be had by multiplying this velocity by the maſs L. This gives $\frac{\text{L}\times\sqrt{s\,y}}{\sqrt{\text{L}+y}}$; and this divided by the power expended, or by $\text{L}+y$, gives us the meaſure of the performance; namely, $\frac{\text{L}\sqrt{s\,y}}{\overline{\text{L}+y}\times\sqrt{\text{L}+y}}$.

That this may be a maximum, conſider y as the variable quantity, and make the fluxion of this formula $=o$. This will give us $y=\frac{\text{L}}{2}$.

Now $\text{P}=\text{L}+y$, $=\text{L}+\frac{\text{L}}{2}$, $=\frac{3}{2}\,\text{L}$. Therefore the *whole* load on the outer end of the beam, conſiſting of the water and the counter weight, muſt be two-thirds of the preſſure of the atmoſphere on the ſteam piſton.

We have here ſuppoſed that the expenditure is the atmoſpheric preſſure; and ſo it is if we conſider it mechanically. But the expenditure of which we are ſenſible, and which we are anxious to employ to the beſt advantage, is fuel. Suppoſing this to be employed with the ſame judgement in all caſes, we are almoſt intitled, by what we now know of the production of ſteam, to ſay that the ſteam produced is proportional to the fuel expended. But the ſteam requiſite for merely filling the cylinder is proportional to the area of the piſton, and therefore to the atmoſpheric preſſure. The reſult of our inveſtigation therefore is ſtill juſt; but the ſteam waſted by condenſation on the ſides of the cylinder does not follow this ratio, and this is more than what is neceſſary for merely filling it. This deranges our calculations, and is in favour of large cylinders; but this advantage muſt be in a great meaſure compenſated by a ſimilar variation in the production of the ſteam; for in ſimilar boilers of greater dimenſions the fuel is leſs advantageouſly employed, becauſe the ſurface to which the fuel is applied does not increaſe in the ratio of the capacity, juſt as the ſurface of the cylinder which waſtes the ſteam. The rule may therefore be confided in as pretty exact.

37 Theſe reſults agree with the moſt ſucceſsful practice.

It is a ſatisfactory thing to obſerve theſe reſults agree very well with the moſt ſucceſsful practice. By many changes and trials engineers have eſtabliſhed maxims of conſtruction, which are probably not very far from the beſt. It is a pretty general maxim, that the load of water ſhould be one-half of the atmoſpheric preſſure. They call this loading the engine with $7\frac{1}{2}$ pounds on the inch, and they ſay that ſo ſmall a load is neceſſary on account of the imperfect vacuum. But we have now ſeen that it is neceſſary for giving a reaſonable velocity of motion. Since, in this practice, w is made $\frac{1}{2}$ or $\frac{6}{12}$ths of P, and L ſhould be $\frac{8}{12}$ths of P, and L is $=w+p$; it follows, that the counter weight ſhould be

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$\frac{1}{8}$th of P; and we have found this to be nearly the caſe in ſeveral very good engines.

It muſt be remarked, that in the preceding inveſtigation we introduced a quantity M to expreſs the reſiſtances to the motion of the engine. This was done in order to avoid a very troubleſome inveſtigation. The reſiſtances are of ſuch a nature as to vary with the velocity, and moſt of them as the ſquare of the velocity. This is the caſe with the reſiſtance ariſing from the motion of the water through the piſtons of the pumps, and that ariſing from the friction in the long lift during the working ſtroke. Had we taken the direct method, which is ſimilar to the determination of the motion through a medium which reſiſts in the duplicate ratio of the velocity, we muſt have uſed a very intricate exponential calculus, which few of our readers would have the patience to look at.

But the greateſt part of the quantity m ſuppoſes a motion already known, and its determination depends on this motion. We muſt now ſhow how its different component parts may be computed.

38 Reſiſtance to the motion of the engine computed.

1. What ariſes from the inertia of the moving parts is by far the moſt conſiderable portion of it. To obtain it, we muſt find a quantity of matter which, when placed at the end of the beam, will have the ſame momentum of inertia with that of the whole moving parts in their natural places. Therefore (in the returning ſtroke) add together the weight of the great piſton with its rod and chains; the pit pump-rods, chains, and any weight that is attached to them; the arch-heads and iron-work at the ends of the beam, and $\frac{4}{9}$ths of the weight of the beam itſelf; alſo the plug-beam with its arch-head and chain, multiplied by the ſquare of its diſtance from the axis, and divided by the ſquare of half the length of the beam; alſo the jack-head pump-rod, chain, and arch-head, multiplied by the ſquare of its diſtance from the axis, and divided by the ſquare of the half length of the beam. Theſe articles added into one ſum may be called M, and may be ſuppoſed to move with the velocity of the end of the beam. Suppoſe this beam to have made a ſix-foot ſtroke in two ſeconds, with an uniformly accelerated motion. In one ſecond it would have moved $1\frac{1}{2}$ feet, and would have acquired the velocity of three feet per ſecond. But in one ſecond gravity would have produced a velocity of 32 feet in the ſame maſs. Therefore the accelerating force, which has produced the velocity of three feet, is nearly $\frac{1}{11}$th of the weight. Therefore $\frac{M}{11}$ is the firſt conſtituent of m in the above inveſtigation. If the obſerved velocity is greater or leſs than three feet per ſecond, this value muſt be increaſed or diminiſhed in the ſame proportion.

The ſecond cauſe of reſiſtance, viz. the immerſion of the pump rods in water, is eaſily computed, being the weight of the water which they diſplace.

The third cauſe, the friction of the piſtons, &c. is almoſt inſignificant, and muſt be diſcovered by experiment.

The fourth cauſe depends on the ſtructure of the pumps. Theſe pumps, when made of a proper ſtrength, can hardly have the perforation of the piſton more than a fourth part of the area of the working-barrel; and the velocity with which the water paſſes through it is increaſed at leaſt $\frac{1}{4}$th by the contraction (ſee PUMP). The velocity of the water is therefore five times greater than that of the piſton. A piſton 12 inches diameter, and moving one foot per ſecond, meets with a reſiſtance equal to 20 pounds; and this increaſes as the ſquare of the diameter and as the ſquare of the velocity. If the whole depth of the pit be divided into ſeveral lifts, this reſiſtance muſt be multiplied by the number of lifts, becauſe it obtains in each pump.

Thus we make up the value of m; and we muſt acknowledge that the method is ſtill indirect, becauſe it ſuppoſes the velocity to be known.

We may obtain it more eaſily in another way, but ſtill with this circumſtance of being indirect. We found that p was equal to $\sqrt{\text{L}\,m}$, and conſequently $m=\frac{p^2}{\text{L}}$. Now in any engine L and p can always be had; and unleſs p deviates greatly from the proportion which we determined to be the beſt, the value of m thus obtained will not be very erroneous.

39 Obſervations concerning ſomething preſumed in the inveſtigation.

It was farther preſumed in this inveſtigation, that the motions both up and down were uniformly accelerated; but this cannot be the caſe when the reſiſtances increaſe with the velocity. This circumſtance makes very little change in the working-ſtroke, and therefore the theorem which determines the beſt relation of P to L may be confided in. The reſiſtances which vary with the velocity in this caſe are a mere trifle when compared with the moving power y. Theſe reſiſtances are, 1ſt, The ſtrangling of the water at the entry and at the ſtanding valve of each pump: This is about 37 pounds for a pump 12 inches diameter, and the velocity one foot per ſecond, increaſing in the duplicate ratio of the diameter and velocity. And, 2d, The friction of the water along the whole lift: This for a pump of the ſame ſize and with the ſame velocity, lifting 20 fathoms, is only about $2\frac{1}{2}$ pounds, and varies in the ſimple proportion of the diameter and the depth, and in the duplicate proportion of the velocity. The reſiſtance ariſing from inertia is greater than in the returning ſtroke; becauſe the M in this caſe muſt contain the momentum of the water both of the pit-pumps and the jackhead-pump: but this part of the reſiſtance does not affect the uniform acceleration. We may therefore confide in the propriety of the formula $y=\frac{\text{L}}{2}$. And we may obtain the velocity of this ſtroke at the end of a ſecond with great accuracy as follows. Let $2g$ be the velocity communicated by gravity in a ſecond, and the velocity at the end of the firſt ſecond of the ſteam piſton's deſcent will be ſomewhat leſs than $\frac{y}{\text{M}}\,2g$; where M expreſſes the inertia of all the parts which are in motion during the deſcent of the ſteam piſton, and therefore includes L. Compute the two reſiſtances juſt mentioned for this velocity. Call this r. Then $\frac{y-\frac{1}{2}r}{\text{M}}\,2g$ will give another velocity infinitely near the truth.

But the caſe is very different in the returning ſtroke, and the proper ratio of p to L is not aſcertained with the ſame certainty: for the moving force p is not ſo great in proportion to the reſiſtance m; and therefore the acceleration of the motion is conſiderably affected by it, and the motion itſelf is conſiderably retarded, and in a very moderate time it becomes ſenſibly uniform: for it is preciſely ſimilar to the motion of a heavy body falling

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falling through the air, and may be determined in the manner laid down in the article *RESISTANCE of Fluids*, viz. by an exponential calculus. We ſhall content ourſelves here with ſaying, that the reſiſtances in the preſent caſe are ſo great that the motion would be to all ſenſe uniform before the piſtons have deſcended one-third of their ſtroke, even although there were no other circumſtance to affect it.

40
The motion affected by a circumſtance that deſerves particular conſideration.

But this motion is affected by a circumſtance quite unconnected with any thing yet conſidered, depending on conditions not mechanical, and ſo uncertain, that we are not yet able to aſcertain them with any preciſion; yet they are of the utmoſt importance to the good performance and improvement of the engine, and therefore deſerve a particular conſideration.

The counter weight has not only to puſh down the pump rods, but alſo to *drag* up the great piſton. This it cannot do unleſs the ſteam be admitted into the cylinder. If the ſteam be no ſtronger than common air, it cannot enter the cylinder except *in conſequence* of the piſton's being dragged up. If common air were admitted into the cylinder, ſome force would be required to drag up the piſton, in the ſame manner as it is required to draw up the piſton of a common ſyringe; for the air would ruſh through the ſmall entry of the cylinder in the ſame manner as through the ſmall nozzle of the ſyringe. Some part of the atmoſpheric preſſure is employed in driving in the air with ſufficient velocity to fill the ſyringe, and it is only with the remainder that the admitted air preſſes on the under ſurface of the ſyringe. Therefore ſome of the atmoſpheric preſſure on its upper ſurface is not balanced. This is felt by the hand which draws it up. The ſame thing muſt happen in the ſteam-engine, and ſome part of the counter weight is expended in drawing up the ſteam-piſton. We could tell how much is thus expended if we knew the denſity of the ſteam; for this would tell us the velocity with which its elaſticity would cauſe it to fill the cylinder. If we ſuppoſe it 12 times rarer than air, which it certainly is, and the piſton riſes to the top of the cylinder in two ſeconds, we can demonſtrate that it will enter with a velocity not leſs than 1400 feet per ſecond, whereas 500 feet is enough to make it maintain a denſity $\frac{9}{10}$ths of that of ſteam in equilibrio with the air. Hence it follows, that its elaſticity will not be leſs than $\frac{29}{30}$ths of the elaſticity of the air, and therefore not more than $\frac{1}{30}$th of counter weight will be expended in drawing up the ſteam-piſton.

But all this is on the ſuppoſition that there is an unbounded ſupply of ſteam of undiminiſhed elaſticity. This is by no means the caſe. Immediately before opening the ſteam-cock, the ſteam was iſſuing through the ſafety-valve and all the crevices in the top of the boiler, and (in good engines) was about $\frac{1}{10}$th ſtronger or more elaſtic than air. This had been gathering during ſomething more than the deſcent of the piſton, viz. in about three ſeconds. The piſton riſes to the top in about two ſeconds; therefore about twice and a half as much ſteam as fills the dome of the boiler is now ſhared between the boiler and cylinder. The dome is commonly about ſix times more capacious than the cylinder. If therefore no ſteam is condenſed in the cylinder, the denſity of the ſteam, when the piſton has reached the top, muſt be about $\frac{15}{16}$ths of its former denſity, and ſtill more elaſtic than air. But as much ſteam is condenſed by the cold cylinder, its elaſticity muſt be leſs than this. We cannot tell how much leſs, both becauſe we do not know how much is thus condenſed, and becauſe by this diminution of its preſſure on the ſurface of the boiling water, it muſt be more copiouſly produced in the boiler; but an attentive obſervation of the engine will give us ſome information. The moment the ſteam-cock is opened we have a ſtrong puff of ſteam through the ſnifting valve. At this time, therefore, it is ſtill more elaſtic than air; but after this, the ſnifting valve remains ſhut during the whole riſe of the piſton, and no ſteam any longer iſſues through the ſafety-valve or crevices; nay, the whole dome of the boiler may be obſerved to ſink.

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41
The elaſticity of the ſteam during the aſcent of the piſton greatly diminiſhed.

Theſe facts give abundant proof that the elaſticity of the ſteam during the aſcent of the piſton is greatly diminiſhed, and therefore much of the counter weight is expended in dragging up the ſteam piſton in oppoſition to the unbalanced part of the atmoſpheric preſſure. The motion of the returning ſtroke is therefore ſo much deranged by this foreign and inappreciated circumſtance, that it would have been quite uſeleſs to engage in the intricate exponential inveſtigation, and we muſt ſit down contented with a leſs perfect adjuſtment of the counter weight and weight of water.—Any perſon who attends to the motion of a ſteam-engine will perceive that the deſcent of the pump-rods is ſo far from being accelerated, that it is nearly uniform, and frequently it is ſenſibly retarded towards the end. We learn by the way, that it is of the utmoſt importance not only to have a quick production of ſteam, but alſo a very capacious dome, or empty ſpace above the water in the boiler. In engines where this ſpace was but four or five times the capacity of the cylinder, we have always obſerved a very ſenſible check given to the deſcent of the pump-rods after having made half their ſtroke. This obliges us to employ a greater counter weight, which diminiſhes the column of water, or retards the working ſtroke; it alſo obliges us to employ a ſtronger ſteam, at the riſk of burſting the boiler, and increaſes the expence of fuel.

42
How to know the elaſticity of the ſteam in the cylinder.

It would be a moſt deſirable thing to get an exact knowledge of the elaſticity of the ſteam in the cylinder; and this is by no means difficult. Take a long glaſs tube exactly calibered, and cloſe at the farther end. Put a ſmall drop of ſome coloured fluid into it, ſo as to ſtand at the middle nearly.—Let it be placed in a long box filled with water to keep it of a conſtant temperature. Let the open end communicate with the cylinder, with a cock between. The moment the ſteam-cock is opened, open the cock of this inſtrument. The drop will be puſhed towards the cloſe end of the tube, while the ſteam in the cylinder is more elaſtic than the air, and it will be drawn the other way while it is leſs elaſtic, and, by a ſcale properly adapted to it, the elaſticity of the ſteam correſponding to every poſition of the piſton may be diſcovered. The ſame thing may be done more accurately by a barometer properly conſtructed, ſo as to prevent the oſcillations of the mercury.

43
Neceſſary alſo to know the ſtate of the cylinder during the deſcent of the piſton.

It is equally neceſſary to know the ſtate of the cylinder during the deſcent of the ſteam-piſton. We have hitherto ſuppoſed P to be the full preſſure of the atmoſphere on the area of the piſton, ſuppoſing the vacuum below it to be complete. But the inſpection of our table of elaſticity ſhows that this can never be the caſe, becauſe the cylinder is always of a temperature far above 32°. We have made many attempts to diſcover its temperature.

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perature. We have employed a thermometer in close contact with the side of the cylinder, which soon acquired a steady temperature: this was never less than 145°. We have kept a thermometer in the water which lies on the piston: this never sunk below 135°. It is probable that the cylinder within may be cooled somewhat lower; but for this opinion we cannot give any very satisfactory reason. Suppose it cooled down to 120°; this will leave an elasticity which would support three inches of mercury. We cannot think therefore that the unbalanced pressure of the atmosphere exceeds that of 27 inches of mercury, which is about $13\frac{1}{3}$d pounds on a square inch, or $10\frac{1}{2}$ on a circular inch. And this is the value which we should employ in the equation $P = L + y$. This question may be decided in the same way as the other, by a barometer connected with the inside of the cylinder.

And thus we shall learn the state of the moving forces in every moment of the performance, and the machine will then be as open to our examination as any water or horse mill; and till this be done, or something equivalent, we can only guess at what the machine is actually performing, and we cannot tell in what particulars we can lend it a helping hand. We are informed that Messrs Watt and Boulton have made this addition to some of their engines; and we are persuaded that, from the information which they have derived from it, they have been enabled to make the curious improvements from which they have acquired so much reputation and profit.

44 Quantity of cold water to be injected.

There is a circumstance of which we have as yet taken no notice, viz. the quantity of cold water injected. Here we confess ourselves unable to give any precise instructions. It is clear at first sight that no more than is absolutely necessary should be injected. It must generally be supplied by the engine, and this expends part of its power. An excess is much more hurtful by cooling the cylinder and piston too much, and therefore wasting steam during the next rise of the piston. But the determination of the proper quantity requires a knowledge, which we have not yet acquired, of the quantity of heat contained in the steam in a latent form. As much water must be injected as will absorb all this without rising near to the boiling temperature. But it is of much more importance to know how far we may cool the cylinder with advantage; that is, when will the loss of steam, during the next rise of the piston, compensate for the diminution of its elasticity during its present descent? Our table of elasticities shows us, that by cooling the cylinder to 120°, we still leave an elasticity equal to one-tenth of the whole power of the engine; if we cool it only to 140, we leave an elasticity of one-fifth; if we cool it to a blood-heat, we leave an elasticity of one-twentieth. It is extremely difficult to choose among these varieties. Experience, however, informs us, that the best engines are those which use the smallest quantities of injection water. We know an exceedingly good engine having a cylinder of 30 inches and a six feet stroke, which works with something less than one-fifth of a cubic foot of water at each injection; and we imagine that the quantity should be nearly in the proportion of the capacity of the cylinder. Desaguliers observed, that a very good engine, with a cylinder of 32 inches, worked with 300 inches of water at each injection, which does not much exceed one-sixth of a cubic foot. Mr Watt's observations, by means of the barometer, must have given him much valuable information in this particular, and we hope that he will not always withhold them from the public.

45 This examination, though not satisfactory, may direct the attention to the principal circumstances.

We have gone thus far in the examination, in order seemingly to ascertain the motion of the engine when loaded and balanced in any known manner, and in order to discover that proportion between the moving power and the load which will produce the greatest quantity of work. The result has been very unsatisfactory, because the computation of the returning stroke is acknowledged to be beyond our abilities. But it has given us the opportunity of directing the reader's attention to the leading circumstances in this inquiry. By knowing the internal state of the cylinder in machines of very different goodness, we learn the connection between the state of the steam and the performance of the machine; and it is very possible that the result of a full examination may be, that in situations where fuel is expensive, it may be proper to employ a weak steam which will expend less fuel, although less work is performed by it. We shall see this confirmed in the clearest manner in some particular employments of the new engines invented by Watt and Boulton.

In the mean time, we see that the equation which we gave from the celebrated Abbé Bossut, is in every respect erroneous even for the purpose which he had in view. We also see that the equation which we substituted in its place, and which was intended for determining that proportion between the counter-weight and the moving force, and the load which would render the working stroke and returning stroke of equal duration, is also erroneous, because these two motions are extremely different in kind, the one being nearly uniform, and the other nearly uniformly accelerated. This being supposed true, it should follow that the counter-weight should be reduced to one half; and we have found this to be very nearly true in some good engines which we have examined.

46 An erroneous maxim that the two motions are of equal duration.

We shall add but one observation more on this head. The practical engineers have almost made it a maxim, that the two motions are of equal duration. But the only reason which we have heard for the maxim, is, that it is aukward to see an engine go otherwise. But we doubt exceedingly the truth of this maxim, and, without being able to give any accurate determination, we think that the engine will do more work if the working stroke be made slower than the returning stroke. Suppose the engine so constructed that they are made in equal times; an addition to the counter-weight will accelerate the returning stroke and retard the working stroke. But as the counter-weight is but small in proportion to the unbalanced portion of the atmospheric pressure, which is the moving force of the machine, it is evident that this addition to the counter-weight must bear a much greater proportion to the counter-weight than it does to the moving force, and must therefore accelerate the returning stroke much more than it retards the working stroke, and the time of both strokes taken together must be diminished by this addition and the performance of the machine improved; and this must be the case as long as the machine is not extravagantly loaded. The best machine which we have seen, in respect of performance, raises a column of water whose weight is very nearly two-thirds of the pressure of the atmosphere atmofphere on the pifton, making 11 ftrokes of fix feet each per minute, and the working ftroke was almoft twice as flow as the other. This engine had worked pumps of 12 inches, which were changed for pumps of 14 inches, all other things remaining the fame. In its former ftate it made from 12 and a half to 13 and a half ftrokes per minute, the working ftroke being confiderably flower than the returning ftroke. The load was increafed, by the change of the pumps, nearly in the proportion to three to four. This had retarded the working ftroke; but the performance was evidently increafed in the proportion of 3×13 to 4×11, or of 39 to 44. About 300 pounds were added to the counterweight, which increafed the number of ftrokes to more than 12 per minute. No fenfible change could be obferved in the time of the working ftroke. The performance was therefore increafed in the proportion of 39 to 48. We have therefore no hefitation in faying, that the feemly equality of the two ftrokes is a facrifice to fancy. The engineer who obferves the working ftroke to be flow, fears that his engine may be thought feeble and unequal to its work; a fimilar notion has long mifled him in the conftruction of watermills, efpecially of overfhot mills; and, even now, he is fubmitting with hefitation and fear to the daily correction of experience.

It is needlefs to engage more deeply in fcientific calculations in a fubject where fo many of the data are fo very imperfectly underftood.

47 The load of work fhould not be lefs than 10 pounds for every fquare inch of the pifton.

We venture to recommend as a maxim of conftruction (fuppofing always a large boiler and plentiful fupply of pure fteam unmixed with air), that the load of work be not lefs than 10 pounds for every fquare inch of the pifton, and the counter-weight fo proportioned that the time of the returning ftroke may not exceed two-thirds of that of the working ftroke. A ferious objection may be made to this maxim, and it deferves mature confideration. Such a load requires the utmoft care of the machine, that no admiffion be given to the common air; and it precludes the poffibility of its working, in cafe the growth of water, or deepening the pit, fhould make a greater load abfolutely neceffary. Thefe confiderations muft be left to the prudence of the engineer. The maxim now recommended relates only to the beft actual performance of the engine.

48 Rules for computing the performance of the fteam-engine.

Before quitting this machine, it will not be amifs to give fome eafy rules, fanctioned by fuccefsful practice, for computing its performance. Thefe will enable any artift, who can go through fimple calculations, to fuit the fize of his engine to the tafk which it is to perform.

The circumftance on which the whole computation muft be founded is the quantity of water which muft be drawn in a minute, and the depth of the mine; and the performance which may be expected from a good engine is at leaft 12 ftrokes per minute of fix feet each, working againft a column of water whofe weight is equal to half of the atmofpheric preffure on the fteam-pifton, or rather to 7.64 pounds on every fquare inch of its furface.

It is moft convenient to eftimate the quantity of water in cubic feet, or its weight in pounds, recollecting that a cubic foot of water weighs $62\frac{1}{2}$ pounds. The depth of the pit is ufually reckoned in fathoms of fix feet, and the diameter of the cylinder and pump is ufually reckoned in inches.

Let Q be the quantity of water to be drawn per minute in cubical feet, and f the depth of the mine in fathoms; let c be the diameter of the cylinder, and p that of the pump; and let us fuppofe the arms of the beam to be of equal length.

1ft, To find the diameter of the pump, the area of the pifton in fquare feet is $p^2 \times \frac{0.7854}{144}$. The length of the column drawn in one minute is 12 times 6 or 72 feet, and therefore its folid contents is $p^2 \times \frac{72 \times 0.7854}{144}$ cubical feet, or $p^2 \times 0.3927$ cubical feet. This muft be equal to Q; therefore p^2 muft be $\frac{Q}{0.3927}$ or nearly $Q \times 2\frac{1}{2}$. Hence this practical rule: Multiply the cubic feet of water which muft be drawn in a minute by $2\frac{1}{2}$, and extract the fquare root of the product: this will be the diameter of the pump in inches.

Thus fuppofe that 58 cubic feet muft be drawn every minute; 58 multiplied by $2\frac{1}{2}$ gives 145, of which the fquare root is 12, which is the required diameter of the pump.

2. To find the proper diameter of the cylinder.

The pifton is to be loaded with 7.64 pounds on every fquare inch. This is equivalent to fix pounds on a circular inch very nearly. The weight of a cylinder of water an inch in diameter and a fathom in height is $2\frac{1}{21}$ pounds, or nearly two pounds. Hence it follows that $6c^2$ muft be made equal to $2fp^2$, and that c^2 is equal to $\frac{2fp^2}{6}$, or to $\frac{fp^2}{3}$.

Hence the following rule: Multiply the fquare of the diameter of the pump pifton (found as above) by the fathoms of lift, and divide the product by 3; the fquare root of the quotient is the diameter of the cylinder.

Suppofe the pit to which the foregoing pump is to be applied is 24 fathoms deep; then $\frac{24 \times 144}{3}$ gives 1152, of which the fquare root is 34 inches very nearly.

This engine conftructed with care will certainly do the work.

Whatever is the load of *water* propofed for the engine, let 10 be the pounds on every circular inch of the fteam pifton, and make $c^2 = p^2 \times \frac{2f}{m}$, and the fquare root will be the diameter of the fteam pifton in inches.

To free the practical engineer as much as poffible from all trouble of calculation, we fubjoin the following *TABLE of the Dimenfions and Power of the Steam Engine*, drawn up by Mr Beighton in 1717, and fully verified by practice fince that time. The meafure is in Englifh ale gallons of 282 cubic inches.

49
Mr Beighton's table of the dimensions and power of the steam-engine.

Diam. of pump.	Hhds in one yard.	Draws by a six feet stroke.	Weighs in one yard.	At 16 strokes per min.	Ditto in hogsheads.	Ditto per hour.	The depth to be drawn in yards.											
Inch.	Gall.	Gall.	Lb. avoir.	Gall.	Hd. Gal	Hd. Gal	15	20	25	30	35	40	45	50	60	70	80	90
12	14.4	28.8	146	462	7.21	440.	18½	21¾	24	26½	28½	30½	32½	34¼	37½	40	43½	
11	12.13	24.26	123.5	338	6.20	369.33	17	19¾	22	25	26¼	28	29¼	31¼	34½	37	39½	
10	10.02	20.04	102	320	5.5	304.48	15½	18	20	22	23¼	25¼	27	28¾	31¼	34	36	38½
9	8.12	16.24	82 7	259.8	4.7	247.7	14	16¼	18	20	21½	23	24¼	25	28	30½	33	35
8½	7.26	14.52	73.9	232 3	3.43	221.15	13½	15¾	17¼	19	20¼	21¾	23	24	26¼	28½	31	32½
8	6.41	12.82	65.3	205.2	3.16	195.22	12½	14½	16½	18½	19	20½	21½	23	25	27	29	30½
7¾	6.01	12.02	61.2	192.3	3.2	182.13	12	14	15½	17½	18¼	19¾	21	22	24¼	26	28	29½
7½	5.66	11.32	57.6	181.1	2.55	172.30	11	13¾	15	16½	18	19	20	21¼	23¼	25	27	28½
7	4.91	9.82	50.0	157.1	2.31	149.40	10¾	13	14	15½	16¼	18¾	19	20½	22	24	25½	27
6½	4.23	8.46	43	135.3	2.9	128.54	10	12	13	14	15½	16¼	18	19	20	22	23	24½
6	3.61	7.2	36.7	115.5	1.52	110.1	9½	11	12	13	14	15½	16	17	19	20½	22	23
5½	3.13	6.2	31.8	99.2	1.36	94.30		10	11	12	13	14	15	15¾	17	19	20	21
5	2.51	5.0	25.5	80.3	1.7	66.61			10	11	11¾	13	13¾	14	15½	16¾	18½	19½
4½	2.02	4.04	20.5	64.6	1.1	60.60				10	11	11¾	12	13½	14	15	16	17
4	1.6	3.2	16.2	51.2	0.51	48.51					9	10	11	11½	12	13½	14	15

Diameter of cylinder in inches.

The first part of the table gives the size of the pump suited to the growth of water. The second gives the size of the cylinder suited to the load of water. If the depth is greater than any in this table, take its fourth part, and double the diameter of the cylinder. Thus if 150 hogsheads are to be drawn in an hour from the depth of 100 fathoms, the last column of part first gives for 149.40 a pump of seven inches bore. In a line with this, under the depth of 50 yards, which is one-fourth of 100 fathoms, we find 20½, the double of which is 41 inches for the diameter of the cylinder.

It is almost impossible to give a general rule for strokes of different lengths, &c. but any one who professes the ability to erect an engine, should surely know as much arithmetic as will accommodate the rule now given to any length of stroke.

We venture to say, that no ordinary engineer can tell *à priori* the number per minute which an engine will give. We took 12 strokes of six feet each for a standard, which a careful engineer may easily accomplish, and which an employer has a right to expect, the engine being loaded with water to half the pressure of the atmosphere: if the load be less, there is some fault—an improper counter weight, or too little boiler, or leaks, &c. &c.

50
Mr Fitzgerald's method of converting its reciprocating motion into a continued rotatory motion.

Such is the state in which Newcomen's steam-engine had continued in use for 60 years, neglected by the philosopher, although it is the most curious object which human ingenuity has yet offered to his contemplation, and abandoned to the efforts of the unlettered artist. Its use has been entirely confined to the raising of water. Mr Keane Fitzgerald indeed published in the Philosophical Transactions a method of converting its reciprocating motion into a continued rotatory motion by employing the great beam to work a crank or a train of wheel-work. As the real action of the machine is confined to its working stroke, to accomplish this, it became necessary to connect with the crank or wheeled work a very large and heavy fly, which should accumulate in itself the whole pressure of the machine during its time of action, and therefore continue in motion, and urge forward the working machinery, while the steam engine was going through its inactive returning stroke. This will be the case, provided that the resistance exerted by the working machine during the whole period of the working and returning stroke of the steam-engine, together with the friction of both, does not exceed the whole pressure exerted by the steam-engine during its working stroke; and provided that the momentum of the fly, arising from its great weight and velocity, be very great, so that the resistance of the work during one returning stroke of the steam-engine do not make any very sensible dimunition of the velocity of the fly. This is evidently possible and easy. The fly may be made of any magnitude; and being exactly balanced round its axis, it will soon acquire any velocity consistent with the motion of the steam-engine. During the working stroke of the engine it is uniformly accelerated, and by its acquired momentum it produces in the beam the movement of the returning stroke; but in doing this, its momentum is shared with the inert matter of the steam-engine, and consequently its velocity diminished, but not entirely taken away. The next working stroke therefore, by pressing on it afresh, increases its remaining velocity by a quantity nearly equal to the whole that it acquired during the first stroke. We say *nearly*, but not quite equal, because the time of the second working stroke must be shorter than that of the first, on account of the velocity already in the machine. In this manner the fly will be more and more accelerated every succeeding stroke, because the pressure of the engine during the working stroke does more than restore to the fly the momentum which it lost in producing the returning movement of the steam-engine. Now suppose the working part of the machine to be added. The acceleration of the fly during each working stroke of the steam-engine will be less than it was before, because the impelling pressure is now partly employed in driving the working machine, and because the fly will lose more of its momentum during the returning stroke of the steam-engine, part of it being expended in driving the working machine. It is evident, therefore, that a time will

come

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come when the succeffive augmentation of the fly's velocity will ceafe; for, on the one hand, the continual acceleration diminifhes the time of the next working ftroke, and therefore the time of action of the accelerating power. The acceleration muft diminifh in the fame proportion; and on the other hand, the refiftance of the working machine generally, though not always, increafes with its velocity. The acceleration ceafes whenever the addition made to the momentum of the fly during a working ftroke of the fteam-engine is juft equal to what it lofes by driving the machine, and by producing the returning movement of the fteam-engine.

51 An important addition;

This muft be acknowledged to be a very important addition to the engine, and though fufficiently obvious, it is ingenious, and requires confiderable fkill and addrefs to make it effective (B).

The movement of the working machine, or mill of whatever kind, muft be in fome degree hobbling or unequal. But this may be made quite infenfible, by making the fly exceedingly large, and difpofing the greateft part of its weight in the rim. By thefe means its momentum may be made fo great, that the whole force required for driving the mill and producing the returning movement of the engine may bear a very fmall proportion to it. The diminution of its velocity will then be very trifling.

No counter weight is neceffary here, becaufe the returning movement is produced by the inertia of the fly. A counter weight may, however, be employed, and fhould be employed, viz. as much as will produce the returning movement of the fteam-engine. It will do this better than the fame force accumulated in the fly; for this force muft be accumulated in the fly by the intervention of rubbing parts, by which fome of it is loft; and it muft be afterwards returned to the engine with a fimilar lofs. But, for the fame reafon, it would be improper to make the counter weight alfo able to drive the mill during the returning ftroke.

52 but feldom or never adopted.

By this contrivance Mr Fitzgerald hoped to render the fteam-engine of moft extenfive ufe; and he, or others affociated with him, obtained a patent excluding all others from employing the fteam engine for turning a crank. They alfo publifhed propofals for erecting mills of all kinds driven by fteam engines, and ftated very fairly their powers and their advantages. But their propofals do not feem to have acquired the confidence of the public; for we do not know of any mill ever having been erected under this patent.

53 The great expenfe of fuel

The great obftacle to this extenfive ufe of the fteam-engine is the prodigious expenfe of fuel. An engine having a cylinder of four feet diameter, working night and day, confumes about 3400 chaldron (London) of good coals in a year.

This circumftance limits the ufe of fteam-engines exceedingly. To draw water from coal-pits, where they can be ftocked with unfaleable fmall coal, they are of universal employment: alfo for valuable mines, for fupplying a great and wealthy city with water, and a few other purpofes where a great expence can be borne, they are very proper engines; but in a thoufand cafes, where their unlimited powers might be vaftly ferviceable, the enormous expenfe of fuel completely excludes them. We cannot doubt but that the attention of engineers was much directed to every thing that could promife a diminution of this expenfe. Every one had his particular noftrum for the conftruction of his furnace, and fome were undoubtedly more fuccefsful than others. But fcience was not yet fufficiently advanced: It was not till Dr Black had made his beautiful difcovery of latent heat, that we could know the intimate relation between the heat expended in boiling off a quantity of water and the quantity of fteam that is produced.

54 limits the fteam-engines.

Much about the time of this difcovery, viz. 1763, Mr James Watt, eftablifhed in Glafgow in the commercial line, was amufing himfelf with repairing a working model of the fteam engine which belonged to the philofophical apparatus of the univerfity. Mr Watt was a perfon of a truly philofophical mind, eminently converfant in all branches of natural knowledge, and the pupil and intimate friend of Dr Black. In the courfe of the above-mentioned amufement many curious facts in the production and condenfation of fteam occurred to him; and among others, that remarkable fact which is always appealed to by Dr Black as the proof of the immenfe quantity of heat which is contained in a very minute quantity of water in the form of elaftic fteam. When a quantity of water is heated feveral degrees above the boiling point in a clofe digefter, if a hole be opened, the fteam rufhes out with prodigious violence, and the heat of the remaining water is reduced, in the courfe of three or four feconds, to the boiling temperature. The water of the fteam which has iffued amounts only to a very few drops; and yet thefe have carried off with them the whole excefs of heat from the water in the digefter.

55 Mr Watt difcovers that fteam contains an immenfe quantity of heat

56 in his attempts to find out a way to hufband this heat,

Since then a certain quantity of fteam contains fo great a quantity of heat, it muft expend a great quantity of fuel; and no conftruction of furnace can prevent this. Mr Watt therefore fet his invention to work to difcover methods of hufbanding this heat. The cylinder of his little model was heated almoft in an inftant, fo that it could not be touched by the hand. It could not be otherwife, becaufe it condenfed the vapour by abftracting its heat. But all the heat thus communicated to the cylinder, and wafted by it on furrounding bodies, contributed nothing to the performance of the engine,

(B) We do not recollect at prefent the date of this propofal of Mr Fitzgerald; but in 1781 the Abbé Arnal, canon of Alais in Languedoc, entertained a thought of the fame kind, and propofed it for working lighters in the inland navigations; a fcheme which has been fuccefsfully practifed (we are told) in America. His brother, a major of engineers in the Auftrian fervice, has carried the thing much farther, and applied it to manufactures; and the Aulic Chamber of Mines at Vienna has patronized the project: (See *Journal Encyclopedique*, 1781). But thefe fchemes are long pofterior to Mr Fitzgerald's patent, and are even later than the erection of feveral machines driven by fteam-engines which have been erected by Meffrs Watt and Boulton. We think it our duty to ftate thefe particulars, becaufe it is very ufual for our neighbours on the continent to affume the credit of Britifh inventions.

engine, and muſt be taken away at every injection, and again communicated and waſted. Mr Watt quickly underſtood the whole proceſs which was going on within the cylinder, and which we have conſidered ſo minutely, and ſaw that a very conſiderable portion of the ſteam muſt be waſted in warming the cylinder. His firſt attempts were made to aſcertain how much was thus waſted, and he found that it was not leſs than three or four times as much as would fill the cylinder and work the engine. He attempted to diminiſh this waſte by uſing wooden cylinders. But though this produced a ſenſible diminution of the waſte, other reaſons forced him to give them up. He then caſed his metal cylinders in a wooden caſe with light wood aſhes between. By this, and uſing no more injection than was abſolutely neceſſary for the condenſation, he reduced the waſte almoſt one half. But by uſing ſo ſmall a quantity of cold water, the inſide of the cylinder was hardly brought below the boiling temperature; and there conſequently remained in it a ſteam of very conſiderable elaſticity, which robbed the engine of a proportional part of the atmoſpherical preſſure. He ſaw that this was unavoidable as long as the condenſation

57 Diſcovers a method of condenſing the ſteam at a little diſtance from the cylinder,

was performed in the cylinder. The thought ſtruck him to attempt the condenſation in another place. His firſt experiment was made in the ſimpleſt manner. A globular veſſel communicated by means of a long pipe of one inch diameter with the bottom of his little cylinder of four inches diameter and 30 inches long. This pipe had a ſtop-cock, and the globe was immerſed in a veſſel of cold water. When the piſton was at the top, and the cylinder filled with ſtrong ſteam, he turned the cock. It was ſcarcely turned, nay he did not think it completely turned, when the ſides of his cylinder (only ſtrong tin-plate) were cruſhed together like an empty bladder. This ſurpriſed and delighted him. A new cylinder was immediately made of braſs ſufficiently thick, and nicely bored. When the experiment was repeated with this cylinder, the condenſation was ſo rapid, that he could not ſay that any time was expended in it. But the moſt valuable diſcovery was, that the vacuum in the cylinder was, as he hoped, almoſt perfect. Mr Watt found, that when he uſed water in the boiler purged of air by long boiling, nothing that was very ſenſibly inferior to the preſſure of the atmoſphere on the piſton could hinder it from coming quite down to the bottom of the cylinder. This alone was gaining a great deal, for in moſt engines the remaining elaſticity of the ſteam was not leſs than one-eighth of the atmoſpherical preſſure, and therefore took away one-eighth of the power of the engine.

58 And removes the difficulties which attended this improvement by means of pumps.

Having gained this capital point, Mr Watt found many difficulties to ſtruggle with before he could get the machine to continue its motion. The water produced from the condenſed ſteam, and the air which was extricated from it, or which penetrated through unavoidable leaks, behoved to accumulate in the condenſing veſſel, and could not be voided in any way ſimilar to that adopted in Newcomen's engine. He took another method: He applied pumps to extract both, which were worked by the great beam. The contrivance is eaſy to any good mechanic; only we muſt obſerve, that the piſton of the water-pump muſt be under the ſurface of the water in the condenſer, that the water may enter the pump by its own weight, becauſe there is no atmoſpherical preſſure there to force it in. We muſt alſo obſerve, that a conſiderable force is neceſſarily expended here, becauſe, as there is but one ſtroke for rarefying the air, and this rarefaction muſt be nearly complete, the air-pump muſt be of large dimenſions, and its piſton muſt act againſt the whole preſſure of the atmoſphere. Mr Watt, however, found that this force could be eaſily ſpared from his machine, already ſo much improved in reſpect of power.

59 Obſervations on the advantages of theſe diſcoveries.

Thus has the ſteam-engine received a very conſiderable improvement. The cylinder may be allowed to remain very hot; nay, boiling hot, and yet the condenſation be completely performed. The only elaſtic ſteam that now remains is the ſmall quantity in the pipe of communication. Even this ſmall quantity Mr Watt at laſt got rid of, by admitting a ſmall jet of cold water up this pipe to meet the ſteam in its paſſage to the condenſer. This both cooled this part of the apparatus in a ſituation where it was not neceſſary to warm it again, and it quickened the condenſation. He found at laſt that the ſmall pipe of communication was of itſelf ſufficiently large for the condenſation, and that no ſeparate veſſel, under the name of condenſer, was neceſſary. This circumſtance ſhows the prodigious rapidity of the condenſation. We may add, that unleſs this had been the caſe, his improvement would have been vaſtly diminiſhed; for a large condenſer would have required a much larger air-pump, which would have expended much of the power of the engine. By theſe means the vacuum below the piſton is greatly improved: for it will appear clear to any perſon who underſtands the ſubject, that as long as any part of the condenſer is kept of a low temperature, it will abſtract and condenſe the vapour from the warmer parts, till the whole acquires the elaſticity correſponding to the coldeſt part. By the ſame means much of the waſte is prevented, becauſe the cylinder is never cooled much below the boiling temperature. Many engines have been erected by Mr Watt in this form, and their performance gave univerſal ſatisfaction.

We have contented ourſelves with giving a very ſlight deſcription without a figure of this improved engine, becauſe we imagine it to be of very eaſy comprehenſion, and becauſe it is only a preparation for ſtill greater improvements, which, when underſtood, will at the ſame time leave no part of this more ſimple form unexplained.

60 Mr Watt makes the piſton deſcend by the force of ſteam.

During the progreſs of theſe improvements Mr Watt made many experiments on the quantity and denſity of the ſteam of boiling water. Theſe fully convinced him, that although he had greatly diminiſhed the waſte of ſteam, a great deal yet remained, and that the ſteam expended during the riſe of the piſton was at leaſt three times more than what would fill the cylinder. The cauſe of this was very apparent. In the ſubſequent deſcent of the piſton, covered with water much below the boiling temperature, the whole cylinder was neceſſarily cooled and expoſed to the air. Mr Watt's fertile genius immediately ſuggeſted to him the expedient of employing the elaſticity of the ſteam from the boiler to impel the piſton down the cylinder, in place of the preſſure of the atmoſphere; and thus he reſtored the engine to its firſt principles, making it an engine *really moved by ſteam*. As this is a new epoch in its hiſtory, we ſhall be more particular in the deſcription; at the ſame fame time ftill reftricting ourfelves to the effential circumftances, and avoiding every peculiarity which is to be found in the prodigious varieties which Mr Watt has introduced into the machines which he has erected, every individual of which has been adapted to local circumftances, or diverfified by the progrefs of Mr Watt's improvements.

61 Defcription of the machine after thefe improvements were added. Fig. 9.

Let A (fig. 9.) reprefent the boiler. This has received great improvements from his complete acquaintance with the procedure of nature in the production of fteam. In fome of his engines the fuel has been placed in the midft of the water, furrounded by an iron or copper veffel, while the exterior boiler was made of wood, which tranfmits, and therefore waftes the heat very flowly. In others, the flame not only plays round the whole outfide, as in common boilers, but alfo runs along feveral flues which are conducted through the midft of the water. By fuch contrivances the fire is applied to the water in a moft extenfive furface, and for a long time, fo as to impart to it the greateft part of its heat. So fkilfully was it applied in the Albion mills, that although it was perhaps the largeft engine in the kingdom, its unconfumed fmoke was inferior to that of a very fmall brew-houfe. In this fecond engine of Mr Watt, the top of the cylinder is fhut up by a ftrong metal plate *g h*, in the middle of which is a collar or box of leathers *k l*, formed in the ufual manner of a jack-head pump, through which the pifton rod PD, nicely turned and polifhed, can move up and down, without allowing any air to pafs by its fides. From the dome of the boiler proceeds a large pipe BCIOQ, which, after reaching the cylinder with its horizontal part BC, defcends parallel to its fide, fending off two branches, viz. IM to the top of the cylinder, and ON to its bottom. At I is a puppet valve opening from below upwards. At L, immediately below this branch, there is a fimilar valve, alfo opening from below upwards. The pipe defcends to Q, near the bottom of a large ciftern *c d e f*, filled with cold water conftantly renewed. The pipe is then continued horizontally along the bottom of this ciftern (but not in contact), and terminates at R in a large pump ST. The pifton S has clack valves opening upwards, and its rod S *s*, paffing through a collar of leathers at T, is fufpended by a chain to a fmall arch head on the outer arm of the beam. There is a valve R in the bottom of this pump, as ufual, which opens when preffed in the direction QR, and fhuts againft a contrary preffure. This pump delivers its contents into another pump XY, by means of the fmall pipe *t* X, which proceeds from its top. This fecond pump has a valve at X, and a clack in its pifton Z as ufual, and the pifton rod Z *z* is fufpended from another arch head on the outer arm of the beam. The two valves I and L are opened and fhut by means of fpanners and handles, which are put in motion by a plug frame, in the fame manner as in Newcomen's engine.

Laftly, there may be obferved a crooked pipe *a b o*, which enters the upright pipe laterally a little above Q. This has a fmall jet hole at *o*; and the other end *a*, which is confiderably under the furface of the water of the condenfing ciftern, is covered with a puppet valve *v*, whofe long ftalk *v u* rifes above the water, and may be raifed or lowered by hand or by the plug beam. The valves R and X, and the clacks in the piftons S and Z, are opened or fhut by the preffures to which they are immediately expofed.

This figure is not an exact copy of any of Mr Watt's engines, but has its parts fo difpofed that all may come diftinctly into view, and exactly perform their various functions. It is drawn in its quiefcent pofition, the outer end of the beam preponderating by the counter weight, and the pifton P at the top of the cylinder, and the piftons S and Z in their loweft fituations.

In this fituation let us fuppofe that a vacuum is (by any means) produced in all the fpace below the pifton, the valve I being fhut. It is evident that the valve R will alfo be fhut, as alfo the valve *v*. Now let the valve I be opened. The fteam from the boiler, as elaftic as common air, will rufh into the fpace above the pifton, and will exert on it a preffure as great as that of the atmofphere. It will therefore prefs it down, raife the outer end of the beam, and caufe it to perform the fame work as an ordinary engine.

When the pifton P has reached the bottom of the cylinder, the plug frame fhuts the valve I, and opens L. By fo doing the communication is open between the top and bottom of the cylinder, and nothing hinders the fteam which is above the pifton from going along the paffage MLON. The pifton is now equally affected on both fides by the fteam, even though a part of it is continually condenfed by the cylinder, and in the pipe IOQ. Nothing therefore hinders the pifton from being dragged up by the counter weight, which acts with its whole force, undiminifhed by any remaining unbalanced elafticity of fteam. Here therefore this form of the engine has an advantage (and by no means a fmall one) over the common engines, in which a great part of the counter weight is expended in overcoming unbalanced atmofpheric preffure.

Whenever the pifton P arrives at the top of the cylinder, the valve L is fhut by the plug frame, and the valves I and *v* are opened. All the fpace below the pifton is at this time occupied by the fteam which came from the upper part of the cylinder. This being a little wafted by condenfation, is not quite a balance for the preffure of the atmofphere. Therefore, during the afcent of the pifton, the valve R was fhut, and it remains fo. When, therefore, the valve *v* is opened, the cold water of the ciftern muft fpout up through the hole *o*, and condenfe the fteam. To this muft be added the coldnefs of the whole pipe OQS. As faft as it is condenfed, its place is fupplied by fteam from the lower part of the cylinder. We have already remarked, that this fucceffive condenfation is accomplifhed with aftonifhing rapidity. In the mean time, fteam from the boiler preffes on the upper furface of the pifton. It muft therefore defcend as before, and the engine muft perform a fecond working ftroke.

But in the mean time the injection water lies in the bottom of the pipe OQR, heated to a confiderable degree by the condenfation of the fteam; alfo a quantity of air has been difengaged from it and from the water in the boiler. How is this to be difcharged ?—This is the office of the pumps ST and XY. The capacity of ST is very great in proportion to the fpace in which the air and water are lodged. When, therefore, the pifton S has got to the top of its courfe, there muft be a vacuum in the barrel of this pump, and the water and air muft open the valve R and come into it. When the

pifton

pifton S comes down again in the next returning ftroke, this water and air gets through the valve of the pifton; and in the next working ftroke they are difcharged by the pifton into the pump XY, and raifed by its pifton. The air efcapes at Y, and as much of the water as is neceffary is delivered into the boiler by a fmall pipe Y g to fupply its wafte. It is a matter of indifference whether the piftons S and Z rife with the outer or inner end of the beam, but it is rather better that they rife with the inner end. They are otherwife drawn here, in order to detach them from the reft and fhow them more diftinctly.

Such is Mr Watt's fecond engine. Let us examine its principles, that we may fee the caufes of its avowed

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and great fuperiority over the common engines.

Caufes of its fuperiority over common engines are, the full operation of the counter-weight,

We have already feen one ground of fuperiority, the full operation of the counter weight. We are authorifed by careful examination to fay, that in the common engines at leaft one-half of the counter weight is expended in counteracting an unbalanced preffure of the air on the pifton during its afcent. In many engines, which are not the worft, this extends to $\frac{1}{3}$th of the whole preffure. This is evident from the examination of the engine at Montrelaix by Boffut. This makes a very great counter weight neceffary, which exhaufts a proportional part of the moving force.

63

and great faving of fteam.

But the great advantage of Mr Watt's form is the almoft total annihilation of the wafte of fteam by condenfation in the cylinder. The cylinder is always boiling hot, and therefore perfectly dry. This muft be evident to any perfon who underftands the fubject. By the time that Mr Watt had completed his improvements, his experiments on the production of fteam had given him a pretty accurate knowledge of its denfity; and he found himfelf authorized to fay, that the quantity of fteam employed did not exceed twice as much as would fill the cylinder, fo that not above one-half was unavoidably wafted. But before he could bring the engine to this degree of perfection, he had many difficulties to overcome: He inclofed the cylinder in an outer wooden cafe at a fmall diftance from it. This diminifhed the expence of heat by communication to furrounding bodies. Sometimes he allowed the fteam from the boiler to occupy this interval. This undoubtedly prevented all diffipation from the inner cylinder; but in its turn it diffipated much heat by the outer cafe, and a very fenfible condenfation was obferved between them. This has occafioned him to omit this circumftance in fome of his beft engines. We believe it was omitted in the Albion mills.

The greateft difficulty was to make the great pifton tight. The old and effectual method, by water lying on it, was inadmiffible. He was therefore obliged to have his cylinders moft nicely bored, perfectly cylindrical, and finely polifhed; and he made numberlefs trials of different foft fubftances for packing his pifton, which fhould be tight without enormous friction, and which fhould always remain fo, in a fituation perfectly dry, and hot almoft to burning.

After all that Mr Watt has done in this refpect, he thinks that the greateft part of the wafte of fteam which he ftill perceives in his engines arifes from the unavoidable efcape by the fides of the pifton during its defcent.

But the fact is, that an engine of this conftruction, of the fame dimenfions with a common engine, making the fame number of ftrokes of the fame extent, does not confume above one-fourth part of the fuel that is confumed by the beft engines of the common form. It is alfo a very fortunate circumftance, that the performance of the engine is not immediately deftroyed, nor indeed fenfibly diminifhed, by a fmall want of tightnefs in the pifton. In the common engine, if air get in, in this way, it immediately puts a ftop to the work; but although even a confiderable quantity of fteam get paft the pifton during its defcent, the rapidity of condenfation is fuch, that hardly any diminution of preffure can be obferved. 64

Another valuable property of it.

Mr Watt's penetration foon difcovered another moft valuable property of this engine. When an engine of the common form is erected, the engineer muft make an accurate eftimate of the work to be performed, and muft proportion his engine accordingly. He muft be careful that it be *fully* able to execute its tafk; but its power muft not exceed its load in any extravagant degree. This would produce a motion which is too rapid, and which, being alternately in oppofite directions, would occafion jolts which no building or machinery could withftand. Many engines have been fhattered by the pumps drawing air, or a pump-rod breaking; by which accidents the fteam-pifton defcends with fuch rapidity that every thing gives way. But in moft operations of mining, the tafk of the engine increafes, and it muft be fo conftructed at firft as to be able to bear this addition. It is very difficult to manage an engine that is much fuperior to its tafk; and the eafieft way is, to have it almoft full loaded, and to work it only during a few hours each day, and allow the pit water to accumulate during its repofe. This increafes the firft coft, and waftes fuel during the inaction of the engine. 65

is, that it can always be exactly fitted to the load which happens to be on it.

But this new engine can at all times be exactly fitted (at leaft during the working ftroke) to the load of work that then happens to be on it. We have only to adminifter fteam of a proper elafticity. At the firft erection the engine may be equal to twice its tafk, if the fteam admitted above the cylinder be equal to that of common boiling water; but when once the ebullition is fairly commenced, and the whole air expelled from all parts of the apparatus, it is evident, that by damping the fire, fteam of half this elafticity may be continually fupplied, and the water will continue boiling although its temperature does not exceed 185° of Fahrenheit's thermometer. This appears by infpecting our table of vaporous elafticity, and affords another argument for rendering that table more accurate by new experiments. We hope that Mr Watt will not withhold from the public the knowledge which he has acquired on this fubject. It may very poffibly refult from an accurate inveftigation, that it would be advifable to work our fteam-engines with weak fteams, and that the diminution of work may be more than compenfated by the diminution of fuel. It is more probable indeed, and it is Mr Watt's opinion, that the contrary is the cafe, and that it is much more economical to employ great heats. At any rate, the decifion of this queftion is of great importance for improving the engine; and we fee, in the mean time, that the engine can at all times be fitted fo as to perform its tafk with a moderate and manageable motion, and that as the tafk increafes we can increafe the power of the engine.

But

Steam-Engine.

66 One inconvenience

But the method now propoſed has a great inconvenience. While the ſteam is weaker than the atmoſphere, there is an external force tending to ſqueeze in the ſides and bottom of the boiler. This could not be reſiſted when the difference is conſiderable, and common air would ruſh in through every crevice of the boiler and ſoon choke the engine : it muſt therefore be given up.

67 remedied in ſome degree.

But the ſame effect will be produced by diminiſhing the paſſage for the ſteam into the cylinder. For this purpoſe, the puppet valve by which the ſteam enters the cylinder was made in the form of a long taper ſpigot, and it was lodged in a cone of the ſame ſhape ; conſequently the paſſage could be enlarged or contracted at pleaſure by the diſtance to which the inner cone was drawn up.

68 But the remedy attended with ſome difficulties;

In this way ſeveral engines were conſtructed, and the general purpoſe of ſuiting the power of the engine to its taſk was completely anſwered ; but (as the mathematical reader will readily perceive) it was extremely difficult to make this adjuſtment preciſe and conſtant. In a great machine like this going by jerks, it was hardly poſſible that every ſucceſſive motion of the valve ſhould be preciſely the ſame. This occaſioned very ſenſible irregularities in the motion of the engine, which increaſed and became hazardous when the joints worked looſe by long uſe.

69 which Mr Watt's fertile genius completely removed.

Mr Watt's genius, always fertile in reſources, found out a complete remedy for all theſe inconveniences. Making the valve of the ordinary form of a puppet clack, he adjuſted the button of its ſtalk or tail ſo that it ſhould always open full to the ſame height. He then regulated the pins of the plug-frame, in ſuch a manner that the valve ſhould ſhut the moment that the piſton had deſcended a certain proportion (ſuppoſe one-fourth, one-third, one-half, &c.) of the cylinder. So far the cylinder was occupied by ſteam as elaſtic as common air. In preſſing the piſton farther down, it behoved the ſteam to expand, and its elaſticity to diminiſh. It is plain that this could be done in any degree we pleaſe, and that the adjuſtment can be varied in a minute, according to the exigency of the caſe, by moving the plug pins.

In the mean time, it muſt be obſerved, that the preſſure on the piſton is continually changing, and conſequently the accelerating force. The motion therefore will no longer be uniformly accelerated : it will approach much faſter to uniformity ; nay, it may be retarded, becauſe although the preſſure on the piſton at the beginning of the ſtroke may exceed the reſiſtance of the load, yet when the piſton is near the bottom the reſiſtance may exceed the preſſure. Whatever may be the law by which the preſſure on the piſton varies, an ingenious mechanic may contrive the connecting machinery in ſuch a way that the chains or rods at the outer end of the beam ſhall continually exert the ſame preſſure, or ſhall vary their preſſure according to any law he finds moſt convenient. It is in this manner that the watchmaker, by the form of the fuzee, produces an equal preſſure on the wheel-work by means of a very unequal action of the main-ſpring. In like manner, by making the outer arch heads portions of a proper ſpiral inſtead of a circle, we can regulate the force of the beam at pleaſure.

Thus we ſee how much more manageable an engine is in this form than Newcomen's was, and alſo more eaſily inveſtigated in reſpect of its power in its various poſitions. The knowledge of this laſt circumſtance was of mighty conſequence, and without it no notion could be formed of what it could perform. This ſuggeſted to Mr Watt the uſe of the barometer communicating with the cylinder ; and by the knowledge acquired by theſe means has the machine been ſo much improved by its ingenious inventor.

We muſt not omit in this place one deduction made by Mr Watt from his obſervations, which may be called a diſcovery of great importance in the theory of the engine.

70 A diſcovery of Mr Watt of great importance in the theory of the engine. Fig. 10.

Let ABCD (fig. 10.) repreſent a ſection of the cylinder of a ſteam-engine, and EF the ſurface of its piſton. Let us ſuppoſe that the ſteam was admitted while EF was in contact with AB, and that as ſoon as it had preſſed it down to the ſituation EF the ſteam cock is ſhut. The ſteam will continue to preſs it down, and as the ſteam expands its preſſure diminiſhes. We may expreſs its preſſure (exerted all the while the piſton moves from the ſituation AB to the ſituation EF) by the line EF. If we ſuppoſe the elaſticity of the ſteam proportional to its denſity, as is nearly the caſe with air, we may expreſs the preſſure on the piſton in any other poſition, ſuch as KL or DC, by K l and D c, the ordinates of a rectangular hyperbola F l c, of which AE, AB are the aſſymptotes, and A the centre. The accumulated preſſure during the motion of the piſton from EF to DC will be expreſſed by the area EF c DE, and the preſſure during the whole motion by the area ABF c DA.

Now it is well known that the area EF c DE is equal to ABFE multiplied by the hyperbolic logarithm of $\frac{AD}{AE}, = L. \frac{AD}{AE}$, and the whole area ABF c DA is $= ABFE \times \left(1 + L. \frac{AD}{AE}\right)$.

Thus let the diameter of the piſton be 24 inches, and the preſſure of the atmoſphere on a ſquare inch be 14 pounds ; the preſſure on the piſton is 6333 pounds. Let the whole ſtroke be 6 feet, and let the ſteam be ſtopped when the piſton has deſcended 18 inches, or 1.5 feet. The hyperbolic logarithm of $\frac{6}{1.5}$ is 1.3862943. Therefore the accumulated preſſure ABF c DA is $= 6333 \times 2.3862943, = 15114$ pounds.

As few profeſſional engineers are poſſeſſed of a table of hyperbolic logarithms, while tables of common logarithms are or ſhould be in the hands of every perſon who is much engaged in mechanical calculations, let the following method be practiſed. Take the common logarithm of $\frac{AD}{AE}$, and multiply it by 2.3026 ; the product is the hyperbolic logarithm of $\frac{AD}{AE}$.

The accumulated preſſure while the piſton moves from AB to EF is 6333×1, or ſimply 6333 pounds. Therefore the ſteam while it expands into the whole cylinder adds a preſſure of 8781 pounds.

Suppoſe that the ſteam had got free admiſſion during the whole deſcent of the piſton, the accumulated preſſure would have been 6333×4, or 25332 pounds.

Here Mr Watt obſerved a remarkable reſult. The ſteam expended in this caſe would have been four times greater

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greater than when it was ftopped at one-fourth, and yet the accumulated preffure is not twice as great, being nearly five-thirds. One-fourth of the fteam performs nearly three-fifths of the work, and an equal quantity performs more than twice as much work when thus admitted during one-fourth of the motion.

This is a curious and an important information, and the advantage of this method of working a fteam-engine increafes in proportion as the fteam is fooner ftopped; but the increafe is not great after the fteam is rarefied four times. The curve approaches near to the axis, and fmall additions are made to the area. The expenfe of fuch great cylinders is confiderable, and may fometimes compenfate this advantage.

Let the fteam be ftopped at			Its performance is mult.
$\frac{1}{2}$	-	-	1.7
$\frac{1}{3}$	-	-	2.1
$\frac{1}{4}$	-	-	2.4
$\frac{1}{5}$	-	-	2.6
$\frac{1}{6}$	-	-	2.8
$\frac{1}{7}$	-	-	3.
$\frac{1}{8}$	-	-	3.2
&c.			&c.

It is very pleafing to obferve fo many unlooked-for advantages refulting from an improvement made with the fole view of leffening the wafte of fteam by condenfation. While this purpofe is gained, we learn how to hufband the fteam which is not thus wafted. The engine becomes more manageable, and is more eafily adapted to every variation in its tafk, and all its powers are more eafily computed.

The active mind of its ingenious inventor did not ftop here: It had always been matter of regret that one-half of the motion was unaccompanied by any work. It was a very obvious thing to Mr Watt, that as the fteam admitted above the pifton preffed it down, fo fteam admitted below the pifton preffed it up with the fame force, provided that a vacuum were made on its upper fide. This was eafily done, by connecting the lower end of the cylinder with the boiler and the upper end with the condenfer.

Plate DIII. Fig. 11.

71 Defcription of Mr Watt's fteam-engine in its moft improved ftate.

Fig. 11. is a reprefentation of this conftruction exactly copied from Mr Watt's figure accompanying his fpecification. Here BB is a fection of the cylinder, furrounded at a fmall diftance by the cafe 1111. The fection of the pifton A, and the collar of leathers which embraces the pifton rod, gives a diftinct notion of its conftruction, of the manner in which it is connected with the pifton-rod, and how the packing of the pifton and collar contributes to make all tight.

From the top of the cylinder proceeds the horizontal pipe. Above the letter D is obferved the feat of the fteam valve, communicating with the box above it. In the middle of this may be obferved a dark fhaded circle. This is the mouth of the upper branch of the fteam pipe coming from the boiler. Beyond D, below the letter N, is the feat of the upper condenfing valve. The bottom of the cylinder is made fpherical, fitting the pifton, fo that they may come into entire contact. Another horizontal pipe proceeds from this bottom. Above the letter E is the feat of the lower fteam valve, opening into the valve box. This box is at the extremity of another fteam pipe marked C, which branches off from the upper horizontal part, and defcends obliquely, coming forward to the eye. The lower part is reprefented as cut open, to fhow its interior conformation. Beyond this fteam valve, and below the letter F, may be obferved the feat of the lower condenfing valve. A pipe defcends from hence, and at a fmall diftance below unites with another pipe GG, which comes down from the upper condenfing valve N. Thefe two eduction-pipes thus united go downwards, and open at L into a rectangular box, of which the end is feen at L. This box goes backward from the eye, and at its farther extremity communicates with the air-pump K, whofe pifton is here reprefented in fection with its butterfly valves. The pifton delivers the water and air laterally into another rectangular box M, darkly fhaded, which box communicates with the pump I. The pifton-rods of this and of the air-pump are fufpended by chains from a fmall arch head on the inner arm of the great beam. The lower part of the eduction-pipe, the horizontal box L, the air-pump K, with the communicating box M between it and the pump I, are all immerfed in the cold water of the condenfing ciftern. The box L is made flat, broad, and fhallow, in order to increafe its furface and accelerate the condenfation. But that this may be performed with the greateft expedition, a fmall pipe H, open below (but occafionally ftopped by a plug valve), is inferted laterally into the eduction-pipe G, and then divides into two branches; one of which reaches within a foot or two of the upper valve N, and the other approaches as near to the valve F.

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As it is intended by this conftruction to give the pifton a ftrong impulfe in both directions, it will not be proper to fufpend its rod by a chain from the great beam; for it muft not only pull down that end of the beam, but alfo pufh it upwards. It may indeed be fufpended by double chains like the piftons of the engines for extinguifhing fires; and Mr Watt has accordingly done fo in fome of his engines. But in his drawing from which this figure is copied, he has communicated the force of the pifton to the beam by means of a toothed rack OO, which engages or works in the toothed fector QQ on the end of the beam. The reader will underftand, without any farther explanation, how the impulfe given to the pifton in either direction is thus tranfmitted to the beam without diminution. The fly XX, with its pinion Y, which alfo works in the toothed arch QQ, may be fuppofed to be removed for the prefent, and will be confidered afterwards.

We fhall take the prefent opportunity of defcribing Mr Watt's method of communicating the force of the fteam-engine to any machine of the rotatory kind. VV reprefents the rim and arms of a very large and heavy metalline fly. On its axis is the concentric toothed wheel U. There is attached to the end of the great beam a ftrong and ftiff rod TT, to the lower end of which a toothed wheel W is firmly fixed by two bolts, fo that it cannot turn round. This wheel is of the fame fize and in the fame vertical plane with the wheel U; and an iron link or ftrap (which cannot be feen here, becaufe it is on the other fide of the two wheels) connects the centres of the two wheels, fo that the one cannot quit the other. The engine being in the pofition reprefented in the figure, fuppofe the fly to be turned once round by any external force in the direction of the darts. It is plain, that fince the toothed wheels cannot quit each other, being kept together by the

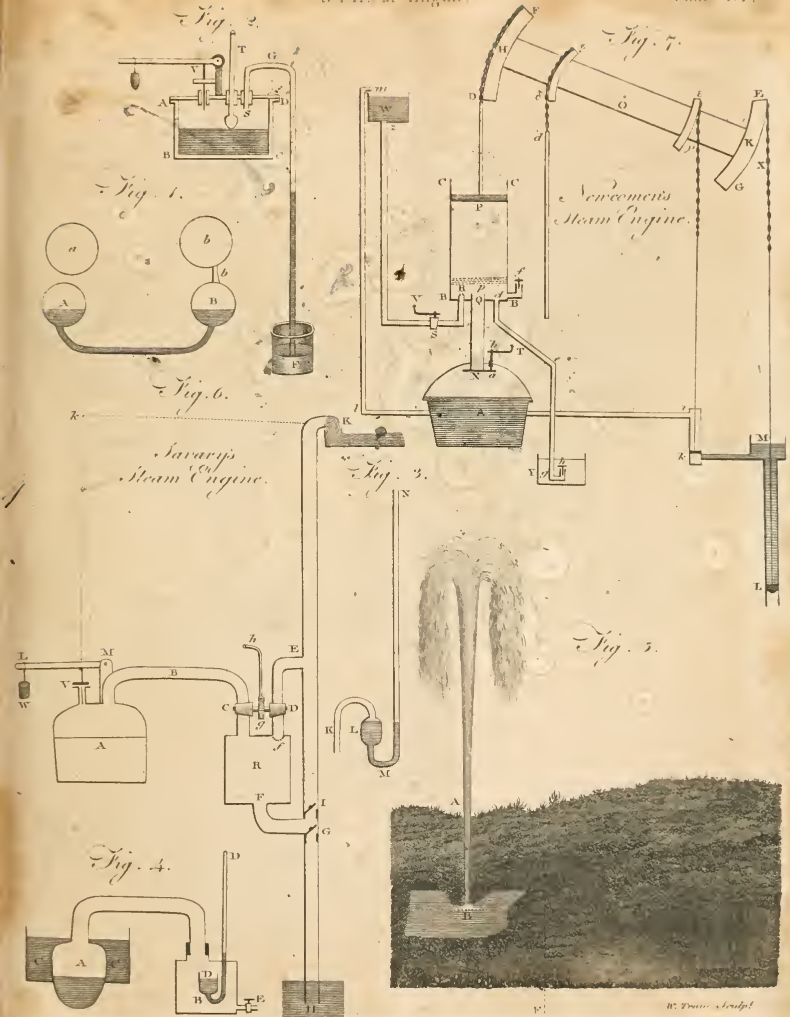


Fig. 2.
Fig. 1.
Fig. 7.
Newcomen's Steam Engine.
Fig. 6.
Savary's Steam Engine.
Fig. 3.
Fig. 5.
Fig. 4.

BEIGHTON'S STEAM ENGINE.

Fig. 8.

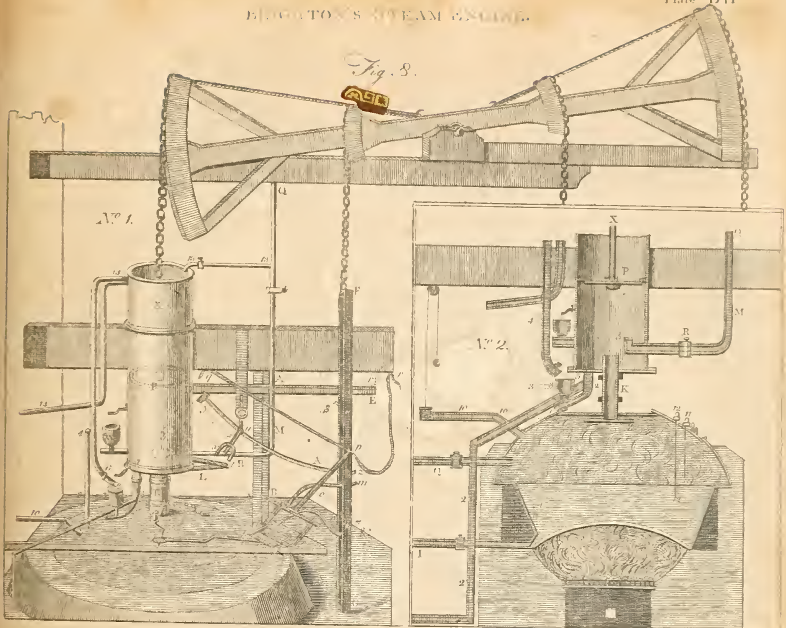


Fig. 9.

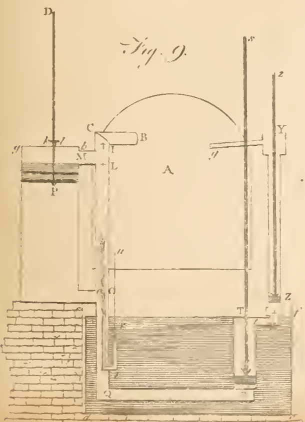
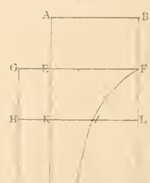
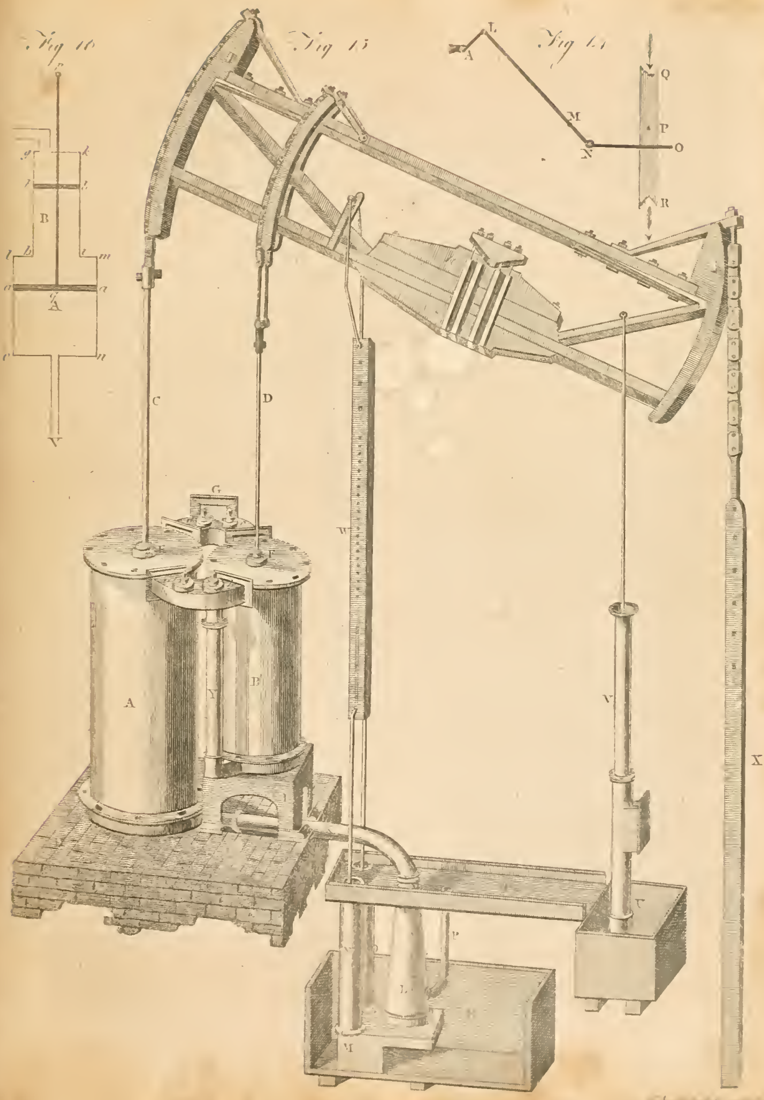


Fig. 10.



Hornblower's
STEAM ENGINE.



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the link, the inner half (that is, the half next the cylinder) of the wheel U will work on the inner half of the wheel W, fo that at the end of the revolution of the fly the wheel W muft have got to the top of the wheel U, and the outer end of the beam muft be raifed to its higheft pofition. The next revolution of the fly will bring the wheel W and the beam connected with it to their firft pofitions; and thus every two revolutions of the fly will make a complete period of the beam's reciprocating movements. Now, inftead of fuppofing the fly to drive the beam, let the beam drive the fly. The motions muft be perfectly the fame, and the afcent or defcent of the pifton will produce one revolution of the fly.

Fig. 12.

A fide view of this apparatus is given in fig. 12. marked by the fame letters of reference. This fhows the fituation of parts which were fore-fhortened in fig. 11. particularly the defcending branch C of the fteam-pipe, and the fituation and communications of the two pumps K and I. 8, 8 is the horizontal part of the fteam-pipe. 9 is a part of it whofe box is reprefented by the dark circle of fig. 11. D is the box of the fteam-clack; and the little circle at its corner reprefents the end of the axis which turns it, as will be defcribed afterwards. N is the place of the upper eduction valve. A part only of the upper eduction-pipe G is reprefented, the reft being cut off, becaufe it would have covered the defcending fteam-pipe CC. When continued down, it comes between the eye and the box E of the lower fteam-valve, and the box F of the lower eduction-valve.

Let us now trace the operation of this machine through all its fteps. Recurring to fig. 11. let us fuppofe that the lower part of the cylinder BB is exhaufted of all elaftic fluids; that the upper fteam-valve D and the lower eduction-valve F are open, and that the lower fteam-valve E and upper eduction-valve N are fhut. It s evident that the pifton muft be preffed toward the bottom of the cylinder, and muft pull down the end of the working beam by means of the toothed rack OO and fector QQ, caufing the other end of the beam to urge forward the machinery with which it is connected. When the pifton arrives at the bottom of the cylinder, the valves D and F are fhut by the plug frame, and E and N are opened. By this laft paffage the fteam gets into the eduction-pipe, where it meets with the injection water, and is rapidly condenfed. The fteam from the boiler enters at the fame time by E, and preffing on the lower fide of the pifton, forces it upwards, and by means of the toothed rack OO and toothed fector QQ forces up that end of the working beam, and caufes the other end to urge forward the machinery with which it is connected: and in this manner the operation of the engine may be continued for ever.

The injection water is continually running into the eduction-pipe, becaufe condenfation is continually going on, and therefore there is a continual atmofpheric preffure to produce a jet. The air which is difengaged from the water, or enters by leaks, is evacuated only during the rife of the pifton of the air-pump K. When this is very copious, it renders a very large air-pump neceffary; and in fome fituations Mr Watt has been obliged to employ two air-pumps, one worked by each arm of the beam. This in every cafe expends a very confiderable portion of the power, for the air-pump is always working againft the whole preffure of the atmofphere.

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It is evident that this form of the engine, by maintaining an almoft conftant and uninterrupted impulfion, is much fitter for driving any machinery of continued motion than any of the former engines, which were inactive during half of their motion. It does not, however, feem to have this fuperiority when employed to draw water: But it is equally fitted for this tafk. Let the engine be loaded with twice as much as would be proper for it if a fingle-ftroke engine, and let a fly be connected with it. Then it is plain that the power of the engine during the rife of the fteam-pifton will be accumulated in the fly; and this, in conjunction with the power of the engine during the defcent of the fteam-pifton, will be equal to the whole load of water.

In fpeaking of the fteam and eduction-valves, we faid that they were all puppet-valves. Mr Watt employed cocks, and alfo fliding-valves, fuch as the regulator or fteam-valves in the old engines. But he found them always lofe their tightnefs after a fhort time. This is not furprifing, when we confider that they are always perfectly dry, and almoft burning hot. He was therefore obliged to change them all for puppet-clacks, which, when truly ground and nicely fitted in their motions at firft, are not found to go out of order by any length of time. Other engineers now univerfally ufe them in the old form of the fteam-engine, without the fame reafons, and merely by fervile and ignorant imitation.

The way in which Mr Watt opens and fhuts thefe valves is as follows. Fig. 13. reprefents a clack with its feat and box. Suppofe it one of the eduction-valves. HH is part of the pipe which introduces the fteam, and GG is the upper part of the pipe which communicates with the condenfer. At EE may be obferved a piece more faintly fhaded than the furrounding parts. This is the feat of the valve, and is a brafs or bell-metal ring turned conical on the outfide, fo as to fit exactly into a conical part of the pipe GG. Thefe two pieces are fitted by grinding; and the cone being of a long taper, the ring fticks firmly in it, efpecially after having been there for fome time and united by ruft. The clack itfelf is a ftrong brafs plate D, turned conical on the edge, fo as to fit the conical or floping inner edge of the feat. Thefe are very nicely ground on each other with emery. This conical joining is much more obtufe than the outer fide of the ring; fo that although the joint is air-tight, the two pieces do not ftick ftrongly together. The clack has a round tail DG, which is freely moveable up and down in the hole of a crofs piece FF. On the upper fide of the valve is a ftrong piece of metal DC firmly joined to it, one fide of which is formed into a toothed rack. A is the fection of an iron axle which turns in holes in the oppofite fides of the valve-box, where it is nicely fitted by grinding, fo as to be air-tight. Collets of thick leather, well foaked in melted tallow and rofin, are fcrewed on the outfide of thefe holes to prevent all ingrefs of air. One end of this axis projects a good way without the box, and carries a fpanner or handle, which is moved by the plug-frame. To this axis is fixed a ftrong piece of metal B, the edge of which is formed into an arch of a circle having the axis A in its centre, and is cut into teeth, which work in the teeth

Fig. 13.

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teeth of the rack DC. K is a cover which is fixed by fcrews to the top of the box HJJH, and may be taken off in order to get at the valve when it needs repairs.

From this defcription it is eafy to fee that by turning the handle which is on the axis A, the fector B muft lift up the valve by means of its toothed rack DC, till the upper end of the rack touch the knob or button K. Turning the handle in the oppofite direction brings the valve down again to its feat.

This valve is extremely tight. But in order to open it for the paffage of the fteam, we muft exert a force equal to the preffure of the atmofphere. This in a large engine is a very great weight. A valve of fix inches diameter fuftains a preffure not lefs that 400 pounds. But this force is quite momentary, and hardly impedes the motion of the engine; for the inftant the valve is detached from its feat, although it has not moved the 100th part of an inch, the preffure is over. Even this little inconvenience has been removed by a delicate thought of Mr Watt. He has put the fpanner in fuch a pofition when it *begins* to raife the valve, that its mechanical energy is almoft infinitely great. Let QR (fig. 14.) be part of the plug-frame defcending, and P one of its pins juft going to lay hold of the fpanner NO moveable round the axis N. On the fame axis is another arm NM connected by a joint with the leader ML, which is connected alfo by a joint with the fpanner LA that is on the axis A of the fector within the valve-box. Therefore when the pin P pufhes down the fpanner NO, the arm NM moves fidewife and pulls down the fpanner AL by means of the connecting rod. Things are fo difpofed, that when the cock is fhut, LM and MN are in one ftraight line. The intelligent mechanic will perceive that, in this pofition, the force of the lever ONM is infuperable. It has this further advantage, that if any thing fhould tend to force open the valve, it would be ineffectual; for no force exerted at A, and tranfmitted by the rod LM, can poffibly pufh the joint M out of its pofition. Of fuch importance is it to practical mechanics, that its profeffors fhould be perfons of penetration as well as knowledge. Yet this circumftance is unheeded by hundreds who have fervilely copied from Mr Watt, as may be feen in every engine that is puffed on the public as a difcovery and an improvement. When thefe puppet-valves have been introduced into the common engine, we have not feen one inftance where this has been attended to; certainly becaufe its utility has not been obferved: and there is one fituation where it is of more confequence than in Mr Watt's engine, viz. in the injection-cock. Here the valve is drawn back into a box, where the water is fo aukwardly difpofed round it that it can hardly get out out of its way, and where the preffure even exceeds that of the atmofphere. Indeed this particular fubftitution of the button-valve for the cock is moft injudicious.

We poftponed any account of the office of the fly XX (fig. 11.), as it is not of ufe in an engine regulated by the fly VV. The fly XX is only for regulating the reciprocating motion of the beam when the fteam is not admitted during the whole defcent of the pifton. This it evidently muft render more uniform, accumulating a momentum equal to the whole preffure of the full fupply of fteam, and then fharing it with the beam during the reft of the defcent of the pifton.

When a perfon properly fkilled in mechanics and chemiftry reviews thefe different forms of Mr Watt's fteam-engine, he will eafily perceive them fufceptible of many intermediate forms, in which any one or more of the diftinguifhing improvements may be employed. The firft great improvement was the condenfation in a feparate veffel. This increafed the original powers of the engine, giving to the atmofpheric preffure and to the counter-weight their full energy; at the fame time the wafte of fteam is greatly diminifhed. The next improvement, by employing the preffure of the fteam inftead of that of the atmofphere, aimed only at a ftill farther diminution of the wafte; but was fertile in advantages, rendering the machine more manageable, and particularly enabling us at all times, and without trouble, to fuit the power of the engine to its load of work, however variable and increafing; and brought into view a very interefting propofition in the mechanical theory of the engine, viz. that the whole performance of a given quantity of fteam may be augmented by admitting it into the cylinder only during a part of the pifton's motion. Mr Watt has varied the application of this propofition in a thoufand ways; and there is nothing about the machine which gives more employment to the fagacity and judgement of the engineer. The third improvement of the double impulfe may be confidered as the finifhing touch given to the engine, and renders it as uniform in its action as any water-wheel. In the engine in its moft perfect form there does not feem to be above one-fourth of the fteam wafted by warming the apparatus; fo that *it is not poffible* to make it one-fourth part more powerful than it is at prefent. The only thing that feems fufceptible of confiderable improvement is the great beam. The enormous ftrains exerted on its arms require a proportional ftrength. This requires a vaft mafs of matter, not lefs indeed in an engine with a cylinder of 54 inches than three tons and a half, moving with the velocity of three feet in a fecond, which muft be communicated in about half a fecond. This mafs muft be brought into motion from a ftate of reft, muft again be brought to reft, again into motion, and again to reft, to complete the period of a ftroke. This confumes much power; and Mr Watt has not been able to load an engine with more than 10 or 11 pounds on the inch and preferve a fufficient quantity of motion, fo as to make 12 or 15 fix-feet ftrokes in a fecond. Many attempts have been made to leffen this mafs by ufing a light framed wheel, or a light frame of carpentry, in place of a folid beam. Thefe have generally been conftructed by perfons ignorant of the true fcientific principles of carpentry, and have fared accordingly. Mr Watt has made fimilar attempts; but found, that although at firft they were abundantly ftrong, yet after a fhort time's employment the ftraps and bolts with which the wooden parts were connected cut their way into the wood, and the framing grew loofe in the joints, and, without giving any warning, went to pieces in an inftant. A folid maffy fimple beam, of fufficient ftrength, bends, and fenfibly complains (as the carpenters exprefs it), before it breaks. In all great engines, therefore, fuch only are employed, and in fmaller engines he fometimes ufes caft-iron wheels or pulleys; nay, he frequently ufes no beam or equivalent whatever, but employs the fteam-pifton rod to drive the machinery to which the engine is applied.

72 Review of Mr Watt's three great improvements.

73 The only improvement now wanting is to ftrength-en the great beam.

We prefume that our thinking readers will not be difpleafed

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diſpleaſed with this rational hiſtory of the progreſs of this engine in the hands of its ingenious and worthy inventor. We owe it to the communications of a friend, well acquainted with him, and able to judge of his merits. The public ſee him always aſſociated with the no leſs celebrated mechanic and philoſopher Mr Boulton of Soho near Birmingham (ſee SOHO). They have ſhared the royal patent from the beginning; and the alliance is equally honourable to both.

74 Mr Watt aſſociated with Mr Boulton.

75 Whence their profits are derived in erecting engines.

The advantages derived from the patent-right ſhow both the ſuperiority of the engine and the liberal minds of the proprietors. They erect the engines at the expence of the employers, or give working drafts of all the parts, with inſtructions, by which any reſident engineer may execute the work. The employers ſelect the beſt engine of the ordinary kind in the kingdom, compare the quantities of fuel expended by each, and pay to Meſſrs Watt and Boulton one-third of the annual ſavings for a certain term of years. By this the patentees are excited to do their utmoſt to make the engine perfect; and the employer pays in proportion to the advantage he derives from it.

It may not be here improper to ſtate the actual performance of ſome of theſe engines, as they have been aſcertained by experiment.

76 What the actual performance of ſome of theſe engines is.

An engine having a cylinder of 31 inches in diameter, and making 17 double ſtrokes per minute, performs the work of forty horſes working night and day (for which three relays or 120 horſes muſt be kept), and burns 11,000 pounds of Staffordſhire coal per day. A cylinder of 19 inches, making 25 ſtrokes of 4 feet each per minute, performs the work of 12 horſes working conſtantly, and burns 3700 pounds of coals per day. A cylinder of 24 inches, making 22 ſtrokes of 5 feet, burns 5500 pounds of coals, and is equivalent to the conſtant work of 20 horſes. And the patentees think themſelves authorized by experience to ſay in general, that theſe engines will raiſe more than 20,000 cubic feet of water 24 feet high for every hundred weight of good pit-coal conſumed by them.

In conſequence of the great ſuperiority of Mr Watt's engines, both with reſpect to economy and manageableneſs, they have become of moſt extenſive uſe; and in every demand of manufacture on a great ſcale they offer us an indefatigable ſervant, whoſe ſtrength has no bounds. The greateſt mechanical project that ever engaged the attention of man was on the point of being executed by this machine. The States of Holland were treating with Meſſrs Watt and Boulton for draining the Haerlem Meer, and even reducing the Zuyder Zee: and we doubt not but that it will be accompliſhed whenever that unhappy nation has ſufficiently felt the difference between liberty and foreign tyranny. Indeed ſuch unlimited powers are afforded by this engine, that the engineer now thinks that no taſk can be propoſed to him which he cannot execute with profit to his employer.

77 Propoſed to drain the Haerlem Meer by the ſteam-engine.

78 The attempts to improve Mr Watt's engine in general of little advantage;

No wonder then that all claſſes of engineers have turned much of their attention to this engine; and ſeeing that it has done ſo much, that they try to make it do ſtill more. Numberleſs attempts have been made to improve Mr Watt's engine; and it would occupy a volume to give an account of them, whilſt that account would do no more than indulge curioſity. Our engineers by profeſſion are in general miſerably deficient in that accurate knowledge of mechanics and of chemiſtry which is neceſſary for underſtanding this machine; and we have not heard of one in this kingdom who can be put on a par with the preſent patentees in this reſpect. Moſt of the attempts of engineers have been made with the humbler view of availing themſelves of Mr Watt's diſcoveries, ſo as to conſtruct a ſteam-engine ſuperior to Newcomen's, and yet of a form ſufficiently different from Watt's to keep it without the reach of his patent. This they have in general accompliſhed by performing the condenſation in a place which, with a little ſtretch of fancy, not unfrequent in a court of law, may be called *part of the cylinder*.

79 and the ſucceſs of theſe has not injured the other.

The ſucceſs of moſt of theſe attempts has interfered ſo little with the intereſt of the patentees, that they have not hindered the erection of many engines which the law would have deemed encroachments. We think it our duty to give our opinion on this ſubject without reſerve. Theſe are moſt expenſive undertakings, and few employers are able to judge accurately of the merits of a project preſented to them by an ingenious artiſt. They may ſee the practicability of the ſcheme, by having a general notion of the expanſion and condenſation of ſteam, and they may be miſled by the ingenuity apparent in the conſtruction. The engineer himſelf is frequently the dupe of his own ingenuity; and it is not always diſhoneſty, but frequently ignorance, which makes him prefer his own invention or (as he thinks it) improvement. It is a moſt delicate engine, and requires much knowledge to ſee what does and what does not improve its performance. We have gone into the preceding minute inveſtigation of Mr Watt's progreſs with the expreſs purpoſe of making our readers fully maſters of its principles, and have more than once pointed out the real improvements, that they may be firmly fixed and always ready in the mind. By having recourſe to them, the reader may pronounce with confidence on the merits of any new conſtruction, and will not be deceived by the puffs of an ignorant or diſhoneſt engineer.

80 Exception in favour of Mr Hornblower.

We muſt except from this general criticiſm a conſtruction by Mr Jonathan Hornblower near Briſtol, on account of its ſingularity, and the ingenuity and real ſkill which appears in ſome particulars of its conſtruction. The following ſhort deſcription will ſufficiently explain its principle, and enable our readers to appreciate its merit.

Plate DIV. Description of his ſteam-engine.

A and B (fig. 15.) repreſent two cylinders, of which A is the largeſt. A piſton moves in each, having their rods C and D moving through collars at E and F. Theſe cylinders may be ſupplied with ſteam from the boiler by means of the ſquare pipe G, which has a flanch to connect it with the reſt of the ſteam-pipe. This ſquare part is repreſented as branching off to both cylinders. *c* and *d* are two cocks, which have handles and tumblers as uſual, worked by the plug-beam W. On the fore-ſide (that is, the ſide next the eye) of the cylinders is repreſented another communicating pipe, whoſe ſection is alſo ſquare or rectangular, having alſo two cocks *a*, *b*. The pipe Y, immediately under the cock *b*, eſtabliſhes a communication between the upper and lower parts of the ſmall cylinder B, by opening the cock *b*. There is a ſimilar pipe on the other ſide of the cylinder A, immediately under the cock *d*. When the cocks *c* and *a* are open, and the cocks *b* and *d* are ſhut, the ſteam from the boiler has free admiſſion into the upper part of the cylinder B, and the ſteam from

from the lower part of B has free admiſſion into the upper part of A; but the upper part of each cylinder has no communication with its lower part.

From the bottom of the great cylinder proceeds the eduction-pipe K, having a valve at its opening into the cylinder, which bends downwards, and is connected with the conical condenſer L (c). The condenſer is fixed on a hollow box M, on which ſtand the pumps N and O for extracting the air and water; which laſt runs along the trough T into a ciſtern U, from which it is raiſed by the pump V for recruiting the boiler, being already nearly boiling hot. Immediately under the condenſer there is a ſpigot valve at S, over which is a ſmall jet pipe, reaching to the bend of the eduction-pipe. The whole of the condenſing apparatus is contained in a ciſtern R of cold water. A ſmall pipe P comes from the ſide of the condenſer, and terminates on the bottom of the trough T, and is there covered with a valve Q, which is kept tight by the water that is always running over it. Laſtly, the pump-rods X cauſe the outer end of the beam to preponderate, ſo that the quieſcent poſition of the beam is that repreſented in the figure, the piſtons being at the top of the cylinders.

Suppoſe all the cocks open, and ſteam coming in copiouſly from the boiler, and no condenſation going on in L; the ſteam muſt drive out all the air, and at laſt follow it through the valve Q. Now ſhut the valves *b* and *d*, and open the valve S of the condenſer. The condenſation will immediately commence. There is now no preſſure on the under ſide of the piſton of A, and it immediately deſcends. The communication between the lower part of B and the upper part of A being open, the ſteam will go from B into the ſpace left by the piſton of A. It muſt therefore expand, and its elaſticity muſt diminiſh, and will no longer balance the preſſure of the ſteam above the piſton of B. This piſton therefore, if not withheld by the beam, would deſcend till it is in equilibrio, having ſteam of equal denſity above and below it. But it cannot deſcend ſo far; for the cylinder A is wider than B, and the arm of the beam at which its piſton hangs is longer than the arm which ſupports the piſton of B: therefore when the piſton of B has deſcended as far as the beam will permit it, the ſteam between the two piſtons occupies a larger ſpace than it did when both piſtons were at the tops of their cylinders. Its denſity, therefore, and its elaſticity, diminiſh as its bulk increaſes. It is therefore not a balance; for the ſteam on the upper ſide of B, and the piſton B, *pulls* at the beam with all the difference of theſe preſſures. The ſlighteſt view of the ſubject muſt ſhow the reader, that as the piſtons deſcend, the ſteam that is between them will grow continually rarer and leſs elaſtic, and that both piſtons will pull the beam downwards.

Suppoſe now that each has reached the bottom of its cylinder. Shut the cock *a* and the eduction cock at the bottom of A, and open the cocks *b* and *d*. The communication being now eſtabliſhed between the upper and lower part of each cylinder, nothing hinders the counter weight from raiſing the piſtons to the top. Let them arrive there. The cylinder B is at this time filled with ſteam of the ordinary denſity, and the cylinder A with an equal abſolute quantity of ſteam, but expanded into a larger ſpace.

Shut the cocks *b* and *d*, and open the cock *a*, and the eduction cock at the bottom of A; the condenſation will again operate, and the piſtons deſcend. And thus the operation may be repeated as long as ſteam is ſupplied; and one full of the cylinder B of ordinary ſteam is expended during each working ſtroke.

Let us now examine the power of this engine. It is evident, that when both piſtons are at the top of their reſpective cylinders, the active preſſure (that is, the difference of the preſſure on its two ſides) on the piſton of B is nothing, while that on the piſton of A is equal to the full preſſure of the atmoſphere on its area. This, multiplied by the length of the arm by which it is ſupported, gives its mechanical energy. As the piſtons deſcend, the preſſure on the piſton of B increaſes, while that on the piſton of A diminiſhes. When both are at the bottom, the preſſure on the piſton of B is at its maximum, and that on the piſton of A at its minimum.

Mr Hornblower ſaw that this muſt be a beneficial employment of ſteam, and preferable to the practice of condenſing it while its full elaſticity remained; but he has not conſidered it with the attention neceſſary for aſcertaining the advantage with preciſion.

Let a and b repreſent the areas of the piſtons of A and B, and let α and β be the lengths of the arms by which they are ſupported. It is evident, that when both piſtons have arrived at the bottoms of their cylinders, the capacities of the cylinders are as $a\,\alpha$ and $b\,\beta$. Let this be the ratio of m to 1. Let $g\,h\,i\,k$ (fig. 16.) and $l\,m\,n\,o$ be two cylinders of equal length, communicating with each other, and fitted with a piſton-rod $p\,q$, on which are fixed two piſtons $a\,a$ and $b\,b$, whoſe areas are as m and 1. Let the diſtance between the piſtons be preciſely equal to the height of each cylinder, which height we ſhall call h. Let x be the ſpace $g\,b$ or $b\,a$, through which the piſtons have deſcended. Let the upper cylinder communicate with the boiler, and the lower cylinder with the condenſer or vacuum V.

Any perſon in the leaſt converſant in mechanics and pneumatics will clearly ſee that the ſtrain or preſſure on the piſton-rod $p\,q$ is preciſely the ſame with the united energies of the two piſton rods of Mr Hornblower's engine, by which they tend to turn the working beam round its axis.

The baſe of the upper cylinder being 1, and its height h, its capacity or bulk is $1\,h$ or h; and this expreſſes the natural bulk of the ſteam which formerly filled it, and is now expanded into the ſpace $b\,h\,l\,a\,a\,m\,i\,b$. The part $b\,h\,i\,b$ is plainly $=h-x$, and the part $l\,a\,a\,m$ is $=m\,x$. The whole ſpace therefore is $m\,x+h-x$, $=h+m\,x-x$, or $h+\overline{m-1}\,x$. Therefore the denſity of the ſteam between the piſtons is $\dfrac{h}{h+\overline{m-1}\,x}$.

Let p be the downward preſſure of the ſteam from the

(c) This, however, was ſtopped by Watt's patent; and the condenſation muſt be performed as in Newcomen's engine, or at leaſt in the cylinder A.

the boiler on the upper piſton *b b*. This piſton is alſo preſſed up with a force $=p\frac{h}{h+\overline{m-1}\,x}$ by the ſteam between the piſtons. It is therefore, on the whole, preſſed downward with a force $=p\left(1-\frac{h}{h+\overline{m-1}\,x}\right)$. The lower piſton *a a*, having a vacuum below it, is preſſed downwards with a force $=p\frac{m\,h}{h+\overline{m-1}\,x}$. Therefore the whole preſſure on the piſton rod downwards is $=p\left(1+\frac{m\,h}{h+\overline{m-1}\,x}-\frac{h}{h+\overline{m-1}\,x}\right), =p\left(1+\frac{\overline{m-1}\,h}{h+\overline{m-1}\,x}\right), =p+\frac{p\,h\,\overline{m-1}}{h+\overline{m-1}\,x}=p+\frac{p\,h}{\frac{h}{m-1}+x}$.

This then is the momentary preſſure on the piſton rod correſponding to its deſcent x from its higheſt poſition. When the piſtons are in their higheſt poſition, this preſſure is equal to $m\,p$. When they are in their loweſt poſition, it is $=p\frac{2\,m-1}{m}$. Here therefore is an acceſſion of power. In the beginning the preſſure is greater than on a ſingle piſton in the proportion of m to 1; and at the end of the ſtroke, where the preſſure is weakeſt, it is ſtill much greater than the preſſure on a ſingle piſton. Thus, if m be 4, the preſſure at the beginning of the ſtroke is $4\,p$, and at the end it is $\frac{7}{4}\,p$, almoſt double, and in all intermediate poſitions it is greater. It is worth while to obtain the ſum total of all the accumulated preſſures, that we may compare it with the conſtant preſſure on a ſingle piſton.

We may do this by conſidering the momentary preſſure $p+\frac{p\,h}{\frac{h}{m-1}+x}$, as equal to the ordinate GF, H*b*, or M*c*, of a curve F*b c* (fig. 10.), which has for its axis the line GM equal to h the height of our cylinder. Call this ordinate y. We have $y=p+\frac{p\,h}{\frac{h}{m-1}x}$, and $y-p=\frac{p\,h}{\frac{h}{m-1}+x}$. Now it is plain that $\frac{p\,h}{\frac{h}{m-1}+x}$ is the ordinate of an equilateral hyperbola, of which $p\,h$ is the power or rectangle of the ordinate and abſciſs, and of which the abſciſs reckoned from the centre is $\frac{h}{m-1}+x$. Therefore make $\mathrm{GE}=p$, and draw DEA parallel to MG, and make $\mathrm{EA}=\frac{\mathrm{GM}}{m-1}, =\frac{h}{m-1}$. The curve F*b c* is an equilateral hyperbola, having A for its centre and AD for its aſſymptote. Draw the other aſſymptote AB, and its ordinate FB. Since the power of the hyperbola is $=p\,h$, =GEDM (for GE$=p$, and GM$=h$); and ſince all the inſcribed rectangles, ſuch as AEFB, are equal to $p\,h$, it follows that AEFB is equal to GEDM, and that the area ABF*c*DA is equal to the area GF*c*MG, which expreſſes the accumulated preſſure in Hornblower's engine.

We can now compute the accumulated preſſure very eaſily. It is evidently $=p\,h\times\left(1+\mathrm{L}.\frac{\mathrm{AD}}{\mathrm{AE}}\right)$.

82 The accumulated preſſure the ſame with that of Mr Watt's engine.

The intelligent reader cannot but obſerve that this is preciſely the ſame with the accumulated preſſure of a quantity of ſteam admitted in the beginning, and ſtopped in Mr Watt's method, when the piſton has deſcended through the mth part of the cylinder. In conſidering Mr Hornblower's engine, the thing was preſented in ſo different a form that we did not perceive the analogy at firſt, and we were ſurpriſed at the reſult. We could not help even regretting it, becauſe it had the appearance of a new principle and an improvement: and we doubt not but that it appeared ſo to the ingenious author; for we have had ſuch proofs of his liberality of mind as permit us not to ſuppoſe that he ſaw it from the beginning, and availed himſelf of the difficulty of tracing the analogy. And as the thing may miſlead others in the ſame way, we have done a ſervice to the public by ſhowing that this engine, ſo coſtly and ſo difficult in its conſtruction, is no way ſuperior in power to Mr Watt's ſimple method of ſtopping the ſteam. It is even inferior, becauſe there muſt be a condenſation in the communicating paſſages. We may add, that if the condenſation is performed in the cylinder A, which it muſt be unleſs with the permiſſion of Watt and Boulton, the engine cannot be much ſuperior to a common engine; for much of the ſteam from below B will be condenſed between the piſtons by the coldneſs of the cylinder A; and this diminiſhes the downward preſſure on A more than it increaſes the downward preſſure on B. We learn however that, by confining the condenſation to a ſmall *part of the cylinder* A, Mr Hornblower has erected engines clear of Mr Watt's patent, which are conſiderably ſuperior to Newcomen's: ſo has Mr Symington.

83 Still, however, the engine diſcovers ingenuity and ſkill.

We ſaid that there was much ingenuity and real ſkill obſervable in many particulars of this engine. The diſpoſition and connection of the cylinders, and the whole condenſing apparatus, are contrived with peculiar neatneſs. The cocks are very ingenious; they are compoſed of two flat circular plates ground very true to each other, and one of them turns round on a pin through their centres; each is pierced with three ſectoral apertures, exactly correſponding with each other, and occupying a little leſs than one-half of their ſurfaces. By turning the moveable plate ſo that the apertures coincide, a large paſſage is opened for the ſteam; and by turning it ſo that the ſolid of the one covers the aperture of the other, the cock is ſhut. Such regulators are now very common in the caſt iron ſtoves for warming rooms.

Mr Hornblower's contrivance for making the collars for the piſton rods air-tight is alſo uncommonly ingenious. This collar is in fact two, at a ſmall diſtance from each other. A ſmall pipe, branching off from the main ſteam-pipe, communicates with the ſpace between the collars. This ſteam, being a little ſtronger than the preſſure of the atmoſphere, effectually hinders the air from penetrating by the upper collar; and though a little ſteam ſhould get through the lower collar into the cylinder A, it can do no harm. We ſee many caſes in which this pretty contrivance may be of ſignal ſervice.

But

Steam-Engine.

84

The great eſt improvement is the framing of the working beam.

But it is in the framing of the great working beam that Mr Hornblower's ſcientific knowledge is moſt conſpicuous; and we have no heſitation in affirming that it is ſtronger than a beam of the common form, and containing twenty times its quantity of timber. There is hardly a part of it expoſed to a tranverſe ſtrain, if we except the ſtrain of the pump V on the ſtrutt by which it is worked. Every piece is either puſhed or pulled in the direction of its length. We only fear that the bolts which connect the upper beam with the two iron bars under its ends will work looſe in their holes, and tear out the wood which lies between them. We would propoſe to ſubſtitute an iron bar for the whole of this upper beam. This working beam highly deſerves the attention of all carpenters and engineers. We have that opinion of Mr Hornblower's knowledge and talents, that we are confident that he will ſee the fairneſs of our examination of his engine, and we truſt to his candour for an excuſe for our criticiſm.

85

The reciprocating motion of the ſteam-engine is a defect ſtill to be remedied.

The reciprocating motion of the ſteam-engine has always been conſidered as a great defect; for though it be now obviated by connecting it with a fly, yet, unleſs it is an engine of double ſtroke, this fly muſt be an enormous maſs of matter moving with great velocity. Any accident happening to it would produce dreadful effects: A part of the rim detaching itſelf would have the force of a bomb, and no building could withſtand it. Many attempts have been made to produce a circular motion at once by the ſteam. It has been made to blow on the vanes of a wheel of various forms. But the rarity of ſteam is ſuch, that even if none is condenſed by the cold of the vanes, the impulſe is exceedingly feeble, and the expence of ſteam, ſo as to produce any ſerviceable impulſe, is enormous. Mr Watt, among his firſt ſpeculations on the ſteam engine, made ſome attempts of this kind. One in particular was uncommonly ingenious. It conſiſted of a drum turning air-tight within another, with cavities ſo diſpoſed that there was a conſtant and great preſſure urging it in one direction. But no packing of the common kind could preſerve it air-tight with ſufficient mobility. He ſucceeded by immerſing it in mercury, or in an almagam which remained fluid in the heat of boiling water; but the continual trituration ſoon calcined the fluid and rendered it uſeleſs. He then tried Parent's or Dr Barker's mill, incloſing the arms in a metal drum, which was immerſed in cold water. The ſteam ruſhed rapidly along the pipe which was the axis, and it was hoped that a great reaction would have been exerted at the ends of the arms; but it was almoſt nothing. The reaſon ſeems to be, that the greateſt part of the ſteam was condenſed in the cold arms. It was then tried in a drum kept boiling hot; but the impulſe was now very ſmall in compariſon with the expence of ſteam. This muſt be the caſe.

86

Mr Watt's attempts to produce a circular motion by ſteam unſucceſsful.

Mr Watt has deſcribed in his ſpecification to the patent office ſome contrivances for producing a circular motion by the immediate action of the ſteam. Some of theſe produce alternate motions, and are perfectly analogous to his double-ſtroke engine. Others produce a continued motion. But he has not given ſuch a deſcription of his valves for this purpoſe as can enable an engineer to conſtruct one of them. From any gueſs that we can form, we think the machine very imperfect; and we do not find that Mr Watt has ever erected a continuous circular engine. He has doubtleſs found all his attempts inferior to the reciprocating engine with a fly. A very crude ſcheme of this kind may be ſeen in the Tranſactions of the Royal Society of Dublin 1787. But although our attempts have hitherto failed, we hope that the caſe is not yet deſperate: we ſee different principles which have not yet been employed.

87

Still the caſe is not deſperate, for different principles may be employed.

We ſhall conclude our account of this noble engine with obſerving, that Mr Watt's form ſuggeſts the conſtruction of an excellent air-pump. A large veſſel may be made to communicate with a boiler at one ſide, and with the pump-receiver on the other, and alſo with a condenſer. Suppoſe this veſſel of ten times the capacity of the receiver; fill it with ſteam from the boiler, and drive out the air from it; then open its communication with the receiver and the condenſer. This will rarefy the air of the receiver ten times. Repeating the operation will rarefy it 100 times; the third operation will rarefy it 1000 times; the fourth 10,000 times, &c. All this may be done in half a minute.

88

Mr Watt's engine ſuggeſts the conſtruction of an excellent air pump.

Steam-Kitchen.

STEAM-Kitchen. Ever ſince Dr Papin contrived his digeſter (about the year 1690), ſchemes have been propoſed for dreſſing victuals by the ſteam of boiling water. A philoſophical club uſed to dine at Saltero's coffee-houſe, Chelſea, about 40 years ago, and had their victuals dreſſed by hanging them in the boiler of the ſteam-engine which raiſes water for the ſupply of Picadilly and its neighbourhood. They were completely dreſſed, and both expeditiouſly and with high flavour.

A patent was obtained for an apparatus for this purpoſe by a tin-man in London; we think of the name of Tate. They were afterwards made on a much more effective plan by Mr Gregory, an ingenious tradeſman in Edinburgh, and are coming into very general uſe.

It is well known to the philoſopher that the ſteam of boiling water contains a prodigious quantity of heat, which it retains in a latent ſtate ready to be faithfully accounted for, and communicated to any colder body. Every cook knows the great ſcalding power of ſteam, and is diſpoſed to think that it is much hotter than boiling water. This, however, is a miſtake; for it will raiſe the thermometer no higher than the water from which it comes. But we can aſſure the cook, that if he make the ſteam from the ſpout of a tea-kettle paſs through a great body of cold water, it will be condenſed or changed into water; and when one pound of water has in this manner been boiled off, it will have heated the maſs of cold water as much as if we had thrown into it ſeven or eight hundred pounds of boiling hot water.

If, therefore, a boiler be properly fitted up in a furnace, and if the ſteam of the water boiling in it be conveyed by a pipe into a pan containing victuals to be dreſſed, every thing can be cooked that requires no higher degree of heat than that of boiling water: And this will be done without any riſk of ſcorching, or any kind of overheating, which frequently ſpoils our diſhes, and proceeds from the burning heat of air coming to thoſe parts of the pot or pan which is not filled with liquor, and is covered only with a film, which quickly burns and taints the whole diſh. Nor will the cook be ſcorched by the great heat of the open fire that is neceſſary for dreſſing at once a number of diſhes, nor have his perſon and clothes ſoiled by the ſmoke and ſoot unavoidable in the cooking on an open fire. Indeed the whole

whole proceſs is ſo neat, ſo manageable, ſo open to inſpection, and ſo cleanly, that it need neither fatigue nor offend the delicacy of the niceſt lady.

We had great doubts, when we firſt heard of this as a general mode of cookery, as to its economy; we had none as to its efficacy. We thought that the ſteam, and conſequently the fuel expended, muſt be vaſtly greater than by the immediate uſe of an open fire; but we have ſeen a large tavern dinner expeditiouſly dreſſed in this manner, ſeemingly with much leſs fuel than in the common method. The following ſimple narration of facts will ſhow the ſuperiority. In a paper manufactory in this neighbourhood, the vats containing the pulp into which the frames are dipped are about ſix feet diameter, and contain above 200 gallons. This is brought to a proper heat by means of a ſmall cockle or furnace in the middle of the liquor. This is heated by putting in about one hundred weight of coals about eight o'clock in the evening, and continuing this till four next morning, renewing the fuel as it burns away. This method was lately changed for a ſteam heater. A furnace, having a boiler of five or ſix feet diameter and three feet deep, is heated about one o'clock in the morning with two hundred weight of coals, and the water kept in briſk ebullition. Pipes go off from this boiler to ſix vats, ſome of which are at 90 feet diſtance. It is conveyed into a flat box or veſſel in the midſt of the pulp, where it condenſes, imparting its heat to the ſides of the box, and thus heats the ſurrounding pulp. Theſe ſix vats are as completely heated in three hours, expending about three hundred weight of coals, as they were formerly in eight hours, expending near eighteeen hundred weight of coals. Mr Gregory, the inventor of this ſteam-heater, has obtained (in company with Mr Scott, plumber, Edinburgh) a patent for the invention; and we are perſuaded that it will come into very general uſe for many ſimilar purpoſes. The dyers, hatmakers, and many other manufacturers, have occaſion for large vats kept in a continual heat; and there ſeems no way ſo effectual.

Indeed when we reflect ſeriouſly on the ſubject, we ſee that this method has immenſe advantages conſidered merely as a mode of applying heat. The ſteam may be applied to the veſſel containing the victuals in every part of its ſurface: it may even be made to enter the veſſel, and apply itſelf immediately to the piece of meat that is to be dreſſed, and this without any riſk of ſcorching or overdoing.—And it will give out about $\frac{799}{800}$ of the heat which it contains, and will do this only if it be wanted; ſo that no heat whatever is waſted except what is required for heating the apparatus. Experience ſhows that this is a mere trifle in compariſon of what was ſuppoſed neceſſary. But with an open fire we only apply the flame and hot air to the bottom and part of the ſides of our boiling veſſels: and this application is hurried in the extreme; for to make a great heat, we muſt have a great fire, which requires a prodigious and moſt rapid current of air. This air touches our pans but for a moment, imparts to them but a ſmall portion of its heat; and we are perſuaded that three-fourths of the heat is carried up the chimney, and eſcapes in pure waſte, while another great portion beams out into the kitchen to the great annoyance of the ſcorched cook. We think, therefore, that a page or two of this work will not be thrown away in the deſcription of a contrivance by which a ſaving may be made to the entertainer, and the providing the pleaſures of his table prove a leſs fatiguing taſk to this valuable corps of practical chemiſts.

Plate DV. Fig. 1.

Let A (fig. 1.) repreſent a kitchen-boiler, either properly fitted up in a furnace, with its proper fire-place, aſh-pit, and flue, or ſet on a tripod on the open fire, or built up in the general fire-place. The ſteam-pipe BC riſes from the cover of this boiler, and then is led away with a gentle aſcent in any convenient direction. C repreſents the ſection of this conducting ſteam-pipe. Branches are taken off from the ſide at proper diſtances. One of theſe is repreſented at CDE, furniſhed with a cock D, and having a taper nozzle E, fitted by grinding into a conical piece F, which communicates with an upright pipe GH, which is ſoldered to the ſide of the ſtewing veſſel PQRS, communicating with it by the ſhort pipe I. The veſſel is fitted with a cover OT, having a ſtaple handle V. The piece of meat M is laid on a tin-plate grate KL, pierced with holes like a cullender, and ſtanding on three ſhort feet *n n n*.

The ſteam from the boiler comes in by the pipe I, and is condenſed by the meat and by the ſides of the veſſel, communicating to them all its heat. What is not ſo condenſed eſcapes between the veſſel and its cover. The condenſed water lies on the bottom of the veſſel, mixed with a very ſmall quantity of gravy and fatty matter from the victuals. Frequently, inſtead of a cover, another ſtew-veſſel with a cullender bottom is ſet on this one, the bottom of the one fitting the mouth of the other: and *it is obſerved*, that when this is done, the diſh in the under veſſel is more expeditiouſly and better dreſſed, and the upper diſh is more ſlowly, but as completely ſtewed.

This deſcription of one ſtewing veſſel may ſerve to give a notion of the whole; only we muſt obſerve, that when broths, ſoups, and diſhes with made ſauces or containing liquids, are to be dreſſed, they muſt be put into a ſmaller veſſel, which is ſet into the veſſel PQRS, and is ſupported on three ſhort feet, ſo that there may be a ſpace all round it of about an inch or three quarters of an inch. It is obſerved, that diſhes of this kind are not ſo expeditiouſly cooked as on an open fire, but as completely in the end, only requiring to be turned up now and then to mix the ingredients; becauſe as the liquids in the inner veſſel can never come into ebullition, unleſs the ſteam from the boiler be made of a dangerous heat, and every thing be cloſe confined, there cannot be any of that tumbling motion that we obſerve in a boiling pot.

The performance of this apparatus is far beyond any expectation we had formed of it. In one which we examined, ſix pans were ſtewing together by means of a boiler $10\frac{1}{2}$ inches in diameter, ſtanding on a briſk open fire. It boiled very briſkly, and the ſteam puffed frequently through the chinks between the ſtew-pans and their covers. In one of them was a piece of meat conſiderably above 30 pounds weight. This required above four hours ſtewing, and was then very thoroughly and equally cooked; the outſide being no more done than the heart, and it was near two pounds heavier than when put in, and greatly ſwelled. In the mean time, ſeveral diſhes had been dreſſed in the other pans. As far

Steam-Kitchen.

far as we could judge, this cooking did not consume one-third part of the fuel which an open fire would have required for the same effect.

When we consider this apparatus with a little more knowledge of the mode of operation of fire than falls to the share of the cooks (we speak with deference), and consider the very injudicious manner in which the steam is applied, we think that it may be improved so as to surpass any thing that the cook can have a notion of.

When the steam enters the stew-pan, it is condensed on the meat and on the vessel; but we do not want it to be condensed on the vessel. And the surface of the vessel is much greater than that of the meat, and continues much colder; for the meat grows hot, and continues so, while the vessel, made of metal, which is a very perfect conductor of heat, is continually robbed of its heat by the air of the kitchen, and carried off by it. If the meat touch the side of the pan in any part, no steam can be applied to that part of the meat, while it is continually imparting heat to the air by the intermedium of the vessel. Nay, the meat can hardly be dressed unless there be a current of steam through it; and we think this confirmed by what is observed above, that when another stew-pan is set over the first, and thus gives occasion to a current of steam through its cullender bottom to be condensed by its sides and contents, the lower dish is more expeditiously dressed. We imagine, therefore, that not less than half of the steam is wasted on the sides of the different stew-pans. Our first attention is therefore called to this circumstance, and we wish to apply the steam more economically and effectually.

We would therefore construct the steam-kitchen in the following manner:

Fig. 2. We would make a wooden chest (which we shall call the STEW-CHEST) ABCD (fig. 2.). This should be made of deal, in very narrow slips, not exceeding an inch, that it may not shrink. This should be lined with very thin copper, lead, or even strong tinfoil. This will prevent it from becoming a conductor of heat by soaking with steam. For further security it might be set in another chest, with a space of an inch or two all round, and this space filled with a composition of powdered charcoal and clay. This should be made by first making a mixture of fine potter's clay and water about as thick as poor cream: then as much powdered charcoal must be beat up with this as can be made to stick together. When this is rammed in and dry, it may be hot enough on one side to melt glass, and will not discolour white paper on the other.

This chest must have a cover LMNO, also of wood, having holes in it to receive the stew-pans P, Q, R. Between each pan is a wooden partition, covered on both sides with milled lead or tinfoil. The whole top must be covered with very spongy leather or felt, and made very flat. Each stew-pan must have a bearing or shoulder all round it, by which it is supported, resting on the felt, and lying so true and close that no steam can escape. Some of the pans should be simple, like the pan F, for dressing broths and other liquid dishes. Others should be like E and G, having in the bottom a pretty wide hole H, K, which has a pipe in its upper side, rising about an inch or an inch and half into the stew-pan. The meat is laid on a cullender plate, as in the common way; only there must be no holes in the cullender immediately above the pipe.—These stew-pans must be fitted with covers, or they may have others fitted to their mouths, for warming sauces or other dishes, or stewing greens, and many other subordinate purposes for which they may be fitted.

Steam-Kitchen.

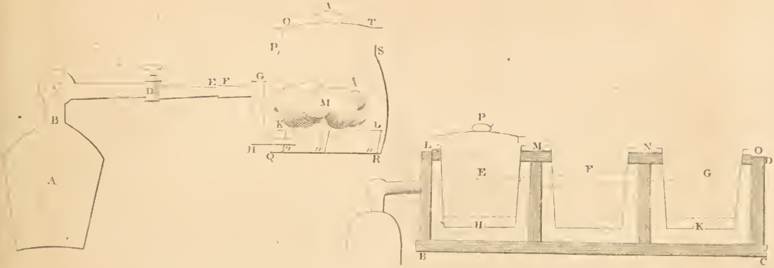
The main-pipe from the boiler must have branches, (each furnished with a cock), which admit the steam into these divisions. At its first entry some will be condensed on the bottom and sides; but we imagine that these will in two minutes be heated so as to condense no more, or almost nothing. The steam will also quickly condense on the stew-pan, and in half a minute make it boiling hot, so that it will condense no more; all the rest will now apply itself to the meat and to the cover. It may perhaps be advisable to allow the cover to condense steam, and even to waste it. This may be promoted by laying on it flannel soaked in water. Our view in this is to create a demand for steam, and thus produce a current through the stew-pan, which will be applied in its passage to the victuals. But we are not certain of the necessity of this. Steam is not like common air of the same temperature, which would glide along the surfaces of bodies, and impart to them a small portion of its heat, and escape with the rest. To produce this effect there *must* be a current; for air hot enough to melt lead, will not boil water, if it be kept stagnant round the vessel. But steam imparts the *whole* of its latent heat to any body colder than boiling water, and goes no farther till this body be made boiling hot. It is a most faithful carrier of heat, and will deliver its whole charge to any body that can take it. Therefore, although there were no partitions in the stew-chest, and the steam were admitted at the end next the boiler, if the pan at the farther end be colder than the rest, it will all go thither; and will, in short, communicate to every thing impartially according to the demand. If any person has not the confidence in the steam which we express, he may still be certain that there must be a prodigious saving of heat by confining the whole in the stew-chest; and he may make the pans with entire bottoms, and admit the steam into them in the common way, by pipes which come through the sides of the chest and then go into the pan. There will be none lost by condensation on the sides of the chest; and the pans will soon be heated up to the boiling temperature; and hardly any of their heat will be wasted, because the air in the chest will be stagnant. The chief reason for recommending our method is the much greater ease with which the stew-pans can be shifted and cleaned. There will be little difference in the performance.

Nay, even the common steam-kitchen may be prodigiously improved by merely wrapping each pan in three or four folds of coarse dry flannel, or making flannel bags of three or four folds fitted to their shape, which can be put on or removed in a minute. It will also greatly conduce to the good performance to wrap the main steam pipe in the same manner in flannel.

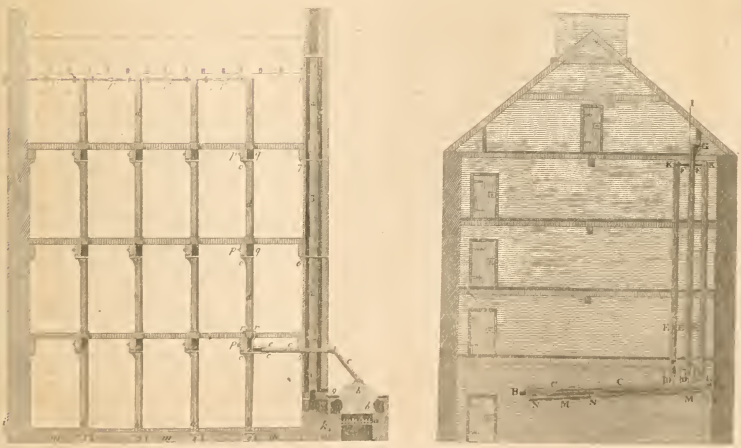
We said that this main-pipe is conducted from the boiler with a gentle ascent. The intention of this is, that the water produced by the unavoidable condensation of the steam may run back into the boiler. But the rapid motion of the steam generally sweeps it up hill, and it runs into the branch-pipes and descends into the stew-pans. Perhaps it would be as well to give the main-

STEAM kitchen

Plate DV.



ROOMS heated by STEAM.



W. Archibald sculp.t

Steam-Kitchen.

main-pipe a declivity the other way, and allow all the water to collect in a hot well at the farther end, by means of a descending pipe, having a loaded valve at the end. This may be so contrived as to be close by the fire, where it would be so warm that it would not check the boiling if again poured into the boiler. But the utmost attention must be paid to cleanliness in the whole of this passage, because this water is boiled again, and its steam passes through the heart of every dish. This circumstance forbids us to return into the boiler what is condensed in the stew-pans. This would mix the tastes and flavours of every dish, and be very disagreeable. All this must remain in the bottom of each stew-pan; for which reason we put in the pipe rising up in the middle of the bottom. It might indeed be allowed to fall down into the stew-chest, and to be collected in a common receptacle, while the fat would float at top, and the clear gravy be obtained below, perhaps fit for many sauces.

The completest method for getting rid of this condensed steam would be to have a small pipe running along the under side of the main conductor, and communicating with it at different places, in a manner similar to the air discharger on the mains of water-pipes. In the paper manufactory mentioned above, each steam-box has a pipe in its bottom, with a float-cock, by which the water is discharged; and the main pipe being of great diameter, and laid with a proper acclivity, the water runs back into the boiler.

But these precautions are of little moment in a steam-kitchen even for a great table; and for the general use of private families, would hurt the apparatus, by making it complex and of nice management. For a small family, the whole apparatus may be set on a table four feet long and two broad, which may be placed on casters, so as to be wheeled out of the way when not in use. If the main conductor be made of wood, or properly cased in flannel, it will condense so little steam that the cooking table may stand in the remotest corner of the kitchen without sensibly impairing its performance; and if the boiler be properly set up in a small furnace, and the flue made so that the flame may be applied to a great part of its surface, we are persuaded that three-fourths of the fuel used in common cookery will be saved. Its only inconvenience seems to be the indispensable necessity of the most anxious cleanliness in the whole apparatus. The most trifling neglect in this will destroy a whole dinner.

We had almost forgotten to observe, that the boiler must be furnished with a funnel for supplying it with water. This should pass through the top, and its pipe reach near to the bottom. It will be proper to have a cock on this funnel. There should also be another pipe in the top of the boiler, having a valve on the top. If this be loaded with a pound on every square inch, and the fire so regulated that steam may be observed to puff sometimes from this valve, we may be certain that it is passing through our dishes with sufficient rapidity; and if we shut the cock on the funnel, and load the valve a little more, we shall cause the steam to blow at the covers of the stew-pans. If one of these be made very tight, and have a hole also furnished with a loaded valve, this pan becomes a digester, and will dissolve bones, and do many things which are impracticable in the ordinary cookery.

Steam.

STEAM applied to Heating Rooms. Steam has been successfully applied as a substitute for open fires in heating manufactories, and promises to be highly beneficial, not only in point of economy in saving fuel, but also in lessening the danger of accidental fire. The following mode of heating a cotton mill by steam was proposed and practised in 1799 by Mr Niel Snodgrass of Paisley. We shall give an account of it in his own words *.

* *Phil. Mag.* xxvii. 174.

Plate DV. Fig. 1

" Fig. 1. presents a view of an inner gable, which is at one extremity of the preparation and spinning rooms of the mill. On the other side of this gable there is a space of 17 feet, enclosed by an outer gable, and containing the water-wheel, the staircase, and small rooms for the accommodation of the work. In this space the furnace and boiler are placed on the ground. The boiler cannot be shown here, as it lies behind the gable exhibited; nor is it of any consequence, as there is nothing peculiar in it. It may be of any convenient form. The feeding apparatus, &c. are in every respect the same as in the boiler of a common steam-engine. A circular copper boiler, two feet diameter by two feet deep, containing 30 gallons of water, with a large copper head as a reservoir for the steam, was found to answer in the present instance. The steam is conveyed from the boiler through the gable, by the copper pipe B, into the tin pipe, C, C. From C it passes into the centres of the perpendicular pipes E, E, E, by the small bent copper tubes D, D, D. The pipes E, E, E, are connected under the garret floor by the tubes F, F, for the more easy circulation of the steam. The middle pipe, E, is carried through the garret floor, and communicates with a lying pipe, 36 feet in length (the end of which is seen at G), for heating the garret. At the further extremity of the pipe G, there is a valve falling inwards to prevent a vacuum being formed on the cooling of the apparatus; the consequence of which would be the crushing of the pipes by the pressure of the atmosphere. Similar valves K, K, are placed near the the top of the perpendicular pipes, E, E; and from the middle one E, the small pipe passes through the roof, and is furnished with a valve at I, opening outwards, to suffer the air to escape while the pipes are filling with steam, or the steam itself to escape when the charge is too high.

" The water condensed in the perpendicular pipes E, E, E, trickles down their sides into the three funnels L, L, L, the necks of which may either pass through or round the pipe C, into the copper tube M, M, which also receives the water condensed in C, C, by means of the short tubes N, N. The pipe C, C, is itself so much inclined as to cause the water to run along it to the tubes N, N, and the pipe G in the garret has an inclination of 18 inches in its length, to bring the water condensed in it back to the middle pipe E. The tube M, M, carries back the water through the gable to the boiler, which stands five feet lower than this tube. It is material to return the water to the boiler, as, being nearly at a boiling heat, a considerable expense of fuel is thereby saved.

" The large pipes are ten inches in diameter, and are made of the second kind of tinned iron plates. The dimensions of the smaller tubes may be seen by their comparative size in the engraving, and perhaps they might be varied without inconvenience.

" The apparatus erected as here described, has been found sufficiently strong, and has required no material repairs re[illegible] ſince the firſt alterations were made. The leading object in the inſtance under conſideration being to ſave fuel, in order to derive as much heat as poſſible from a given quantity of fuel, the flue from the furnace, which heats the boiler, is conveyed into common ſtone pipes placed in the gable. Theſe are erected ſo as to prevent any danger of fire, in the manner ſhown in the engraving, fig. 2. The ſteam with this auxiliary communicates a heat of about 70° to the mill, the rooms of which are 50 feet long, 32½ feet wide, and 8½ feet high, except the lower ſtory and garret; the former of which is 11, and the latter ſeven feet high. The rooms warmed in this manner are much more wholeſome and agreeable than thoſe heated by the beſt conſtructed ſtoves, being perfectly free from vapour or contaminated air.

"The application of the principle to buildings already conſtructed, it is preſumed, will be ſufficiently obvious from the foregoing details. In new manufactories, where the mode of heating may be made a part of the original plan, a more convenient apparatus may be introduced. This will be beſt explained by a deſcription of fig. 2. which gives a ſection of a cotton-mill conſtructed ſo as to apply the ſteam apparatus to a new building.

Fig. 2.

"The furnace for the boiler is ſhown at *a* (fig. 2). The flue of the furnace conveys the ſmoke into the caſt iron ſtove pipes, 1, 2, 3, 4. Theſe pipes are placed in a ſpace in the gable, entirely incloſed with brick, except at the ſmall apertures, 5, 6, 7, 8. A current of air is admitted below at 9, and thrown into the rooms by thoſe openings, after being heated by contact with the pipes. This part of the plan is adopted with a view to prevent, as much as poſſible, any of the heat, produced by the fuel uſed, from being thrown away. It may be omitted where any danger of fire is apprehended from it, and the ſmoke may be carried off in any way that is conſidered abſolutely ſecure. So far, however, as appears from experience, there ſeems to be little or no danger of fire from a ſtove of this conſtruction. The greateſt inconvenience of a common ſtove is, that the cockle or metal furnace is liable to crack from the intenſity of the heat. By the continuity of the metal from the fireplace, an intenſe heat is alſo conducted along the pipes, which expoſes them to the ſame accident. Here the ſmoke being previouſly conveyed through a brick flue, can never communicate to the pipes a degree of heat ſufficient to crack them. In like manner the pipes, having no communication with the rooms but by the ſmall apertures, cannot come in contact with any combuſtible ſubſtance; and from being ſurrounded with air, which is conſtantly changing, can impart only a very moderate degree of heat to the walls. The iron ſupporters of the pipes may be imbedded in ſome ſubſtance which is a bad conductor of heat, as furnace aſhes and lime, &c. The emiſſion of heated air into the rooms may be regulated by valves. As the pipes are not expoſed to cracking, there is no riſk of their throwing ſmoke or vapour into the rooms.

"The boiler *b b*, is ſix feet long, three and a half broad, and three feet deep. As there is nothing peculiar in the feeding apparatus, it is omitted. The boiler may be placed in any convenient ſituation. Where a ſteam engine is uſed for other purpoſes, the ſteam may be taken from its boiler. The pipe *c, c*, conveys the ſteam from the boiler to the firſt perpendicular pipe *d, d, d, d*. There is an expanding joint at *e*, ſtuffed, to make it ſteam-tight. The ſteam aſcending in the firſt pipe *d, d, d*, enters the horizontal pipe *f, f, f, f*, (which is ſlightly inclined) expelling the air, which partly eſcapes by the valve *g*, and is partly forced into the other pipes. The valve *g* being conſiderably loaded, forces the accumulating ſteam down into the reſt of the pipes *d, d, d*. The air in theſe pipes recedes before the ſteam, and is forced through the tubes *h, h, h*, into the pipe *m, m, m*, whence it eſcapes at the valve *i*, and the ſyphon *k*. The water, condenſed in the whole of the pipes, paſſes alſo through the tubes *h, h, h, h*, into the pipe *m, m, m*, which has ſuch a declivity as to diſcharge the water at the ſyphon *k*, into the hot well *n*, whence it is pumped back into the boiler.

"The whole of the pipes are of caſt iron, except *m, m, m*, which is of copper. The perpendicular pipes ſerve as pillars for ſupporting the beams of the houſe, by means of the projecting pieces *o, o, o*, which may be raiſed or lowered at pleaſure by the wedges *p, p, p*. The pipes are ſunk in the beams about an inch, and are made faſt to them by the iron ſtraps *q, q*. Thoſe in the lower ſtory reſt on the ſtones *s, s, s, s*, and are made tight at the junction with ſtuffing. The pipe in each ſtory ſupports the one in the ſtory above by a ſtuffed joint as ſhown at *r*. The pipes in the lower ſtory are ſeven inches in diameter; thoſe in the higher ſix inches; thoſe in the other two are of intermediate diameters. The thickneſs of the metal is three-eighths of an inch. The lower pipes are made larger than the upper, in order to expoſe a greater heated ſurface in the lower rooms, becauſe the ſteam being thrown from above into all the pipes, except the firſt, would otherwiſe become incapable of imparting an equal heat as it deſcends. There is no neceſſity for valves opening inwards in this apparatus, the pipes being ſtrong enough to reſiſt the preſſure of the atmoſphere.

"The cotton mill is 60 feet long, 33 wide, and four ſtories high, the upper being a garret ſtory. In the engraving, five parts out of nine in the length of the building are only ſhown. The apparatus will heat the rooms to 85° in the coldeſt ſeaſon. It is evident that, by increaſing the ſize, or the number of the pipes, and the ſupply of ſteam, any degree of heat up to 212° may be eaſily produced. It may even be carried beyond that point by an apparatus ſtrong enough to compreſs the ſteam: this, however, can ſeldom be wanted. At firſt it was objected to this conſtruction, that the expanſion of the pipes, when heated, might damage the building: but experience has proved, that the expanſion occaſioned by the heat of ſteam is quite inſenſible."

Steam has alſo been advantageouſly employed in drying muſlin goods, when the ſtate of the weather interrupts this proceſs out of doors. This application of ſteam, we underſtand, was the invention of an ingenious mechanic in Paiſley, who never derived the ſmalleſt benefit from the diſcovery. It was adopted immediately by ſome bleachers in the neighbourhood, and has now come into very general uſe. The ſteam is introduced into cylinders of tin plate, and the goods to be dried are wrapped round the cylinders which communicate to them a heat equal at leaſt to the temperature of boiling water, and in this way the proceſs of drying is expeditiouſly accompliſhed.

STEATITES or *Soap-earth*, a ſpecies of mineral belonging

Steatites belonging to the magnesian genus. See MINERALOGY *Index*.

STEATOMA, a kind of encysted tumor, consisting of a matter like suet or lard, soft, without pain, and without discolouring the skin.

STEEL, iron united with carbone, from which it possesses properties distinct from those of iron, and which render it of superior value. From its higher degree of hardness it admits a finer polish and assumes a brighter colour. When tempered, it possesses a higher degree of elasticity, and is also more sonorous. It is more weakly attracted by the loadstone, it receives more slowly the magnetic power, but it preserves it longer. When exposed to a moist air, it does not contract rust so easily as iron. See IRON, CHEMISTRY *Index*.

STEEL-Bow Tenants. See TENURE.

STEEL-Yard, is one of the most ancient presents which science has made to society; and though long in desuetude in this country, is in most nations of the world the only instrument for ascertaining the weight of bodies. What is translated *balance* in the Pentateuch, is in fact steelyard, being the word used by the Arabs to this day for their instrument, which is a steelyard. It is in common use in all the Asiatic nations. It was the *statera* of the Greeks and Romans, and seems to have been more confided in by them than the balance; for which reason it was used by the goldsmiths, while the balance was the instrument of the people.—*Non aurificis statera sed populari trutina examinare*. Cic. de Orat. 238.

The steelyard is a lever of unequal arms, and, in its most perfect form, is constructed much like a common balance. It hangs in the sheers E (fig. 1,) resting on the nail C, and the scale L for holding the goods hangs by a nail D on the short arm BC. The counter weight P hangs by a ring of tempered steel, made sharp in the inside, that it may bear by an edge on the long arm CA of the steelyard. The under edge of the centre nail C, and the upper edge of the nail D, are in the straight line formed by the upper edge of the long arm. Thus the three points of suspension are in one straight line. The needle or index of the steelyard is perpendicular to the line of the arms, and plays between the sheers. The short arm may be made so massive, that, together with the scale, it will balance the long arm unloaded. When no goods are in the scale, and the counter weight with its hook are removed, the steelyard acquires a horizontal position, in consequence of its centre of gravity being below the axis of suspension. The rules for its accurate construction are the same as for a common balance.

Plate DVI. Fig. 1.

The instrument indicates different weights in the following manner: The distance CD of the two nails is considered as an unit, and the long arm is divided into a number of parts equal to it; and these are subdivided as low as is thought proper; or in general, the long arm is made a scale of equal parts, commencing at the edge of the nail C; and the short arm contains some determined number of these equal parts. Suppose, then, that a weight A of 10 pounds is put into the scale L. The counterpoise P must be of such a weight, that, when hanging at the division 10, it shall balance this weight A. Now let any unknown weight W be put into the scale. Slide the hook of the counterpoise along the long arm till it balances this weight. Suppose it then hanging at the division 38. We conclude that there is 38 pounds in the scale. This we do on the authority of the fundamental property of the lever, that forces acting on it, and balancing each other, are in the inverse proportion of the distances from the fulcrum to their lines of direction. Whatever weight the counterpoise is, it is to A as CD to 10, and it is to the weight W as CD to 38; therefore A is to the weight W as 10 to 38, and W is 38 pounds: and thus the weight in the scale will always be indicated by the division at which it is balanced by the counterpoise.

Our well-informed readers know that this fundamental property of the lever was discovered by the renowned Archimedes, or at least first demonstrated by him; and that his demonstration, besides the defect of being applicable only to commensurable lengths of the arms, has been thought by metaphysicians of the first note to proceed on a postulate which seems equally to need a demonstration. It has accordingly employed the utmost refinement of the first mathematicians of Europe to furnish a demonstration free from objection. Mr D'Alembert has given two, remarkable for their ingenuity and subtlety; Foncenex has done the same; and Professor Hamilton of Trinity-college, Dublin, has given one which is thought the least exceptionable. But critics have even objected to this, as depending on a postulate which should have been demonstrated.

The following demonstration by Mr Vince, we think unexceptionable, and of such simplicity that it is astonishing that it has not occurred to any person who thinks on the subject. Fig. 2.

Let AE (fig. 2.) be a mathematical lever, or inflexible straight line, resting on the prop A, and supported at D by a force acting upwards. Let two equal weights b and d be hung on at B and D, equidistant from A and E. Pressures are now exerted at A and E; and because every circumstance of weight and distance is the same, the pressure at E, arising from the action of the weight b on the point B, must be the same with the pressure at A, arising from the action of the weight d on the point D; and the pressure at E, occasioned by the weight d, must be the same with the pressure at A, occasioned by the weight b. This must be the case wherever the weights are hung, provided that the distances AB and DE are equal. Moreover, the sum of the pressures at A and E is unquestionably equal to the sum of the weights, because the weights are supported solely at A and E. Let the two weights be hung on at C the middle point; the pressure at E is still the same. Therefore, in general, the pressure excited at the point E, by two equal weights hanging at any points B and D, is the same as if they were hung on at the middle point between them: but the pressure excited at E is a just measure of the effort or energy of the weights b and d to urge the lever round the point A. It is, at least, a measure of the opposite force which must be applied at E to sustain or balance this pressure. A very fastidious metaphysician may still say, that the demonstration is limited to a point E, whose distance from A is twice AC, or $= AB + AD$. But it extends to any other point on the authority of a postulate which cannot be refused, viz. that in whatever proportion the pressure at E is augmented or diminished, the pressure at this other point must augment or diminish in the same proportion. This being proved, the general theorem may be demonstrated

Steel-yard. ted in all proportions of diftance, in the manner of Archimedes, at once the moft fimple, perfpicuous, and elegant of all.

We cannot help obferving, that all this difficulty (and it is a real one to the philofopher who aims at rendering mechanics a demonftrative fcience) has arifen from an improper fearch after fimplicity. Had Archimedes taken a lever as it really exifts in nature, and confidered it as *material*, confifting of atoms united by cohefion; and had he traced the intermediate preffures by whofe means the two external weights are put in oppofition to each other, or rather to the fupport given to the fulcrum; all difficulty would have vanifhed. (See what is faid on this fubject in the article *STRENGTH of Timber*, &c.

The quantity of goods which may be weighed by this inftrument depends on the weight of the counterpoife, and on the diftance CD from the fulcrum at which the goods are fufpended. A double counterpoife hanging at the fame divifion will balance or indicate a double quantity of goods hanging at D; and any counterpoife will balance and indicate a double quantity of goods, if the diftance CD be reduced to one half. And it fometimes occurs that fteelyards are fo conftructed that they have two or more points of fufpenfion D, to which the fcale may occafionally be attached. It is evident, that in this cafe the value or indication of the divifions of the long arm will be different, according to the point from which the fcale is fufpended. The fame divifion which would indicate 20 pounds when CD is three inches, will indicate 30 pounds when it is two inches. As it would expofe to chance of miftakes, and be otherwife troublefome to make this reduction, it is ufual to make as many divided fcales on the long arm as there are points of fufpenfion D on the fhort arm; and each fcale having its own numbers, all trouble and all chance of miftake is avoided.

But the range of this inftrument is not altogether at the pleafure of the maker. Befides the inability of a flender beam to carry a great load, the divifions of the fcale anfwering to pounds or half-pounds become very minute when the diftance CD is very fhort; and the balance becomes lefs delicate, that is, lefs fenfibly affected by fmall differences of weight. This is becaufe in fuch cafes the thicknefs which it is neceffary to give the edges of the nails does then bear a fenfible proportion to the diftance CD between them; fo that when the balance inclines to one fide, that arm is fenfibly fhortened, and therefore the energy of the preponderating weight is leffened.

We have hitherto fuppofed the fteelyard to be in equilibrio when not loaded. But this is not neceffary, nor is it ufual in thofe which are commonly made. The long arm commonly preponderates confiderably. This makes no difference, except in the beginning of the fcale. The preponderancy of the long arm is equivalent to fome goods already in the fcale, fuppofe four pounds. Therefore when there are really 10 pounds in the fcale, the counterpoife will balance it when hanging at the divifion 6. This divifion is therefore reckoned 10, and the reft of the divifions are numbered accordingly.

A fcientific examination of the fteelyard will convince us that it is inferior to the balance of equal arms in point of fenfibility: But it is extremely compendious and convenient; and when accurately made and attentively ufed, it is abundantly exact for moft commercial purpofes. We have feen one at Leipzig which has been in ufe fince the year 1718, which is very fenfible to a difference of one pound, when loaded with nearly three tons on the fhort arm; and we faw a waggon loaded with more than two tons weighed by it in about fix minutes.

The fteelyard in common ufe in the different countries of Europe is of a conftruction ftill fimpler than what we have defcribed. It confifts of a batten of hard wood, having a heavy lump A (fig. 3.) at one end, and a fwivel-hook B at the other. The goods to be weighed are fufpended on the hook, and the whole is carried in a loop of whip-cord C, in which it is flid backward and forward, till the goods are balanced by the weight of the other end. The weight of the goods is eftimated by the place of the loop on a fcale of divifions in harmonic progreffion. They are marked (we prefume) by trial with known weights. Fig. 3.

The chief ufe that is now made of the fteelyard in thefe kingdoms is for the weighing of loaded waggons and carts. For this it is extremely convenient, and more than fufficiently exact for the purpofe in view. We fhall defcribe one or two of the moft remarkable; and we fhall begin with that at Leipzig already mentioned.

This fteelyard is reprefented in fig. 4. as run out, Fig. 4. and juft about to be hooked for lifting up the load. The fteelyard itfelf is OPQ, and is about 12 feet long. The fhort arm PQ has two points of fufpenfion *c* and *b*; and the ftirrup which carries the chains for holding the load is made with a double hook, inftead of a double eye, that it may be eafily removed from the one pin to the other. For this purpofe the two hooks are connected above an hafp or ftaple, which goes over the arm of the fteelyard like an arch. This is reprefented in the little figure above the fteelyard. The fufpenfion is fhifted when the fteelyard is run in under cover, by hooking to this ftaple the running block of a fmall tackle which hangs in the door through which the fteelyard is run out and in. This operation is eafy, but neceffary, becaufe the ftirrup, chains, and the ftage on which the load is placed, weigh fome hundreds.

The outer pin *b* is 14 inches, and the inner one *c* is feven inches, diftant from the great nail which refts in the fheers. The other arm is about $10\frac{1}{2}$ feet long, formed with an obtufe edge above. On the inclined plane on each fide of the ridge is drawn the fcale of weights adapted to the inner pin *c*. The fcales correfponding to the outer pin *b* are drawn on the upright fides. The counterpoife flides along this arm, hanging from a faddle-piece made of brafs, that it may not contract ruft. The motion is made eafy by means of rollers. This is neceffary, becaufe the counterpoife is greatly above a hundred weight. This faddle-piece has like two laps on each fide, on which are engraved vernier fcales, which divide their refpective fcales on the arm to quarters of a pound. Above the faddle is an arch, from the fummit of which hangs a little plummet, which fhows the equilibrium of the fteelyard to the weigher, becaufe the fheers are four feet out of the houfe, and he cannot fee their coincidence with the needle of the fteelyard. Laftly, near the end of the long arm are

Fig. 4.

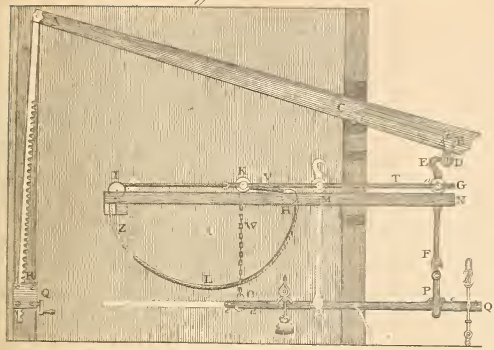


Fig. 2.

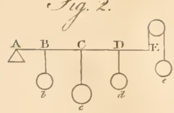


Fig. 1.

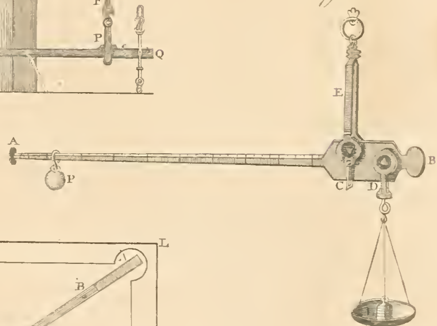
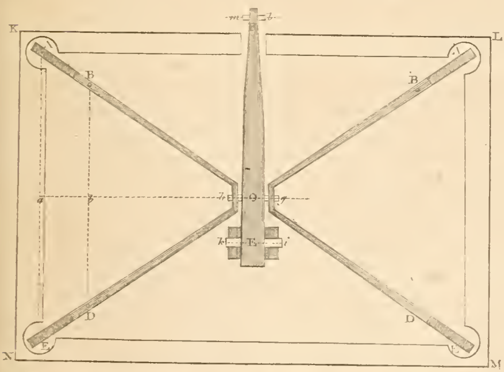


Fig. 5.



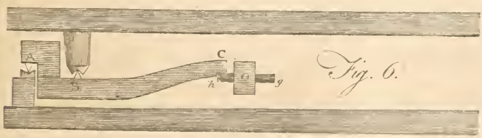
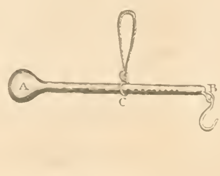


Fig. 6.

Fig. 3.



Steel-yard. are two pins d and e, for fufpending occafionally two eke weights for continuing the fcale. Thefe are kept hanging on adjoining hooks, ready to be lifted on by a little tackle, which is alfo hooked immediately above the pins d and e.

The fcales of weights are laid down on the arm as follows. Let the eke-weights appropriated to the pins d and e be called D and E, and call the counterpoife C. Although the ftirrup with its chains and ftage weigh fome hundreds, yet the length and fize of the arm OP gives it a preponderancy of 300 pounds. Here, then, the fcale of weights muft commence. The counterpoife weighs about 125 pounds. Therefore,

1. When the load hangs by the pin b, 14 inches from the centre, the diftance from one hundred to another on the fcale is about 11 inches, and the firft fcale (on the fide of the arm) reaches from 300 to 1200. In order to repeat or continue this, the eke-weight E is hung on the pin e, and the counterpoife C is brought back to the mark 300; and the two together balance 1100 pounds hanging at b. Therefore a fecond fcale is begun on the fide of the arm, and continued as far out as the firft, and therefore its extremity marks 2000; that is, the counterpoife C at 2000 and the eke-weight E at e balance 2000 hanging at b.

2. To continue the fcale beyond 2000, the load muft be hung on the inner pin c. The eke-weight E is taken off, and the eke-weight D is hung on its pin d. The general counterpoife being now brought clofe to the fheers, it, together with the weight D at d, balance 2000 pounds hanging at c. A fcale is therefore begun on one of the inclined planes a-top, and continued out to 4000, which falls very near to the pin d, each hundred pounds occupying about five inches on the arm. To complete the fcale, hang on the eke-weight E on its pin e, and bring back the counterpoife to the fheers, and the three together balance 3800 hanging at c. Therefore when the counterpoife is now flid out to 4000, it muft complete the balance with 5800 hanging at c.

It required a little confideration to find out what proportion of the three weights C, D, and E, would make the repetitions of the fcale extend as far as poffible, having very little of it expreffed twice, or upon two fcales, as is the cafe here. We fee that the fpace correfponding to a fingle pound is a very fenfible quantity on both fcales, being one-ninth of an inch on the firft two fcales, and one-twentieth on the laft two.

This very ponderous machine, with its maffy weights, cannot be eafily managed without fome affiftance from mechanics. It is extremely proper to have it fufceptible of motion out and in, that it may be protected from the weather, which would foon deftroy it by ruft. The contrivance here is very effectual, and abundantly fimple.

When the fteelyard is not in ufe, it is fupported at one end by the iron rod F, into which the upper end of the fheers is hooked. The upper end of this rod has a ftrong hook E, and a little below at a it is pierced with a hole, in which is a very ftrong bolt or pin of tempered fteel, having a roller on each end clofe to the rod on each fide. Thefe rollers reft on two joifts, one of which is reprefented by MN, which traverfe the building, with juft room enough between them to allow the rod F to hang freely down. The other end O of the fteelyard refts in the bight of a large flat hook at the end of a chain W, which hangs down between Steel-yard. the joifts, and is fupported on them by a frame with rollers H. This is connected with the rollers at G, which carry the fheers by means of two iron-rods, of which one only can be feen. Thefe connect the two fets of rollers in fuch a manner that they muft always move together, and keep their diftance invariable. This motion is produced by means of an endlefs rope HI ZLKVH paffing over the pulleys I and K, which turn between the joifts, and hanging down in a bight between them. It is evident that by pulling on the part LZ we pull the frame of rollers in the direction GH, and thus bring the whole into the houfe in the pofition marked by the dotted figure. It is alfo plain, that by pulling on the part LK we force the roller frame and the whole apparatus out again.

It remains to fhow how the load is raifed from the ground and weighed. When the fteelyard is run out for ufe, the upper hook E juft enters into the ring D, which hangs from the end of the great oaken lever BCA about 22 feet long, turning on gudgeons at C about 5 feet from this end. From the other end A defcends a long iron-rod SR, which has one fide formed into a toothed rack that is acted on by a frame of wheel-work turned by an endlefs fcrew and winch Q. Therefore when the hook E is well engaged in the ring D, a man turns the winch, and thus brings down the end A of the great lever, and raifes the load two or three inches from the ground. Every thing is now at liberty, and the weigher now manages his weights on the arm of the fteelyard till he has made an equilibrium.

We need not defcribe the operation of letting down the load, difengaging the fteelyard from the great lever, and bringing it again under cover. The whole of this fervice is performed by two men, and may be done in fucceffion by one, and is over in five or fix minutes.

The moft compendious and economical machine of this kind that we have feen is one, firft ufed (we have heard) for weighing the riders of race-horfes, and afterwards applied to the more reputable fervice of weighing loaded carriages.

Fig. 5. Fig. 5. is a plan of the machine. KLMN is the plan of a rectangular box, which has a platform lid or cover, of fize fufficient for placing the wheels of a cart or waggon. The box is about a foot deep, and is funk into the ground till the platform cover is even with the furface. In the middle of the box is an iron lever fupported on the fulcrum pin ik, formed like the nail of a balance, which refts with its edge on arches of hardened fteel firmly faftened to the bottom of the box. This lever goes through one fide of the box, and is furnifhed at its extremity with a hard fteel pin lm, alfo formed to an edge below. In the very middle of the box it is croffed by a third nail of hardened fteel gh, alfo formed to an edge, but on the upper fide. Thefe three edges are in one horizontal plane, as in a well made balance.

In the four corners A, A′, E′, E, of the box are firmly fixed four blocks of tempered fteel, having their upper furfaces formed into fpherical cavities, well polifhed and hard tempered. ABCDE reprefents the upper edge of an iron bar of confiderable ftrength, which refts on the cavities of the fteel blocks in A and E, by means of of two hard steel studs projecting from its under edge, and formed into obtuse-angled points or cones. These points are in a straight line parallel to the side KN of the box. The middle part C of this crooked bar is faced with hard-tempered steel below, and is there formed into an edge parallel to AE and KN, by which it rests on the upper edge of the steel pin $g\,h$ which is in the lever. In a line parallel to AE, and on the upper side of the crooked bar ACE, are fixed two studs or points of hardened steel B and D projecting upwards above half an inch. The platform-cover has four short feet like a stool, terminated by hard steel studs, which are shaped into spherical cavities and well polished. With these it rests on the four steel points B, B′, D′, D. The bar ACE is kneed in such a manner vertically, that the points A, B, D, E and the edge C are all in a horizontal plane. These particulars will be better understood by looking at the elevation in fig. 6. What has been said of the bar ACE must be understood as also said of the bar A′ C′ E′.

Draw through the centre of the box the line $a\,b\,c$ perpendicular to the line AE, BD. It is evident that the bar ACE is equivalent to a lever $a\,b\,c$, having the fulcrum or axis AE resting with its extremity C on the pin $h\,g$ and loaded at b. It is also evident that a C is to $a\,b$ as the load on this lever to the pressure which it exerts on the pin $g\,h$, and that the same proportion subsists between the whole load on the platform and the pressure which it exerts on the pin $g\,h$. It will also appear on an attentive consideration, that this proportion is nowise deranged in whatever manner the load is placed on the platform. If very unequably, the two ends of the pin $g\,h$ may be unequally pressed, and the lever wrenched and strained a little; but the total pressure is not changed.

If there be now placed a balance or steelyard at the side LK, in such a manner that one end of it may be directly above the pin $l\,m$ in the end of the lever EOF, they may be connected by a wire or slender rod, and a weight on the other arm of the balance or steelyard may be put in equilibrio with any load that can be laid on the platform. A small counterpoise being first hung on to balance the apparatus when unloaded, any additional weight will measure the load really laid on the platform. If $a\,b$ be to $a\,c$ as 1 to 8, and EO to EF, also as 1 to 8, and if a common balance be used above, 64 pounds on the platform will be balanced by one pound in the scale, and every pound will be balanced by $\frac{1}{4}$th of an ounce. This would be a very convenient partition for most purposes, as it would enable us to use a common balance and common weights to complete the machine: Or it may be made with a balance of unequal arms, or with a steelyard.

Some have thought to improve this instrument by using edges like those of the nails of a balance, instead of points. But unless made with uncommon accuracy, they will render the balance very dull. The small deviation of the two edges A and E, or of B and D, from perfect parallelism to KN, is equivalent to a broad surface equal to the whole deviation. We imagine that, with no extraordinary care, the machine may be made to weigh within $\frac{1}{1000}$ of the truth, which is exact enough for any purpose in commerce.

It is necessary that the points be attached to the bars. Some have put the points at A and E in the blocks of steel fastened to the bottom, because the cavities in these collect water or dirt, which soon destroyed the instrument with rust. But this occasions a change of proportion in the first lever by any shifting of the crooked bars; and this will frequently happen when the wheels of a loaded cart are pushed on the platform. The cavity in the steel stud should have a little rim round it, and it should be kept full of oil. In a nice machine a quarter of an inch of quicksilver would effectually prevent all these inconveniences.

The simplest and most economical form of this machine is to have no balance or second steelyard; but to make the first steelyard EOF a lever of the first kind, viz. having the fulcrum between O and F, and allow it to project far beyond the box. The long or outward arm of this lever is then divided into a scale of weights, commencing at the side of the box. A counterpoise must be chosen, such as will, when at the beginning of the scale, balance the smallest load that will probably be examined. It will be convenient to carry on this scale by means of eke-weights hung on at the *extremity* of the lever, and to use but one moveable weight. By this method the divisions of the scale will always have one value. The best arrangement is as follows: Place the mark O at the beginning of the scale, and let it extend only to 100, if for pounds; or to 112, if for cwts.; or to 10, if for stones; and let the eke-weights be numbered 1, 2, 3, &c. Let the lowest weight be marked on the beam. This is always to be added to the weight shown by the operation. Let the eke-weights stand at the end of the beam, and let the general counterpoise always hang at O. When the cart is put on the platform, the end of the beam tilts up. Hang on the heaviest eke-weight that is not sufficient to press it down. Now complete the balance by sliding out the counterpoise. Suppose the constant load to be 312lb. and that the counterpoise stands at 86, and that the eke-weight is 9; we have the load $=986+312,=1298$lbs.

STEELE, Sir Richard, was born about the year 1676 in Dublin; in which kingdom one branch of the family was possessed of a considerable estate in the county of Wexford. His father, a counsellor at law in Dublin, was private secretary to James duke of Ormond; but he was of English extraction: and his son, while very young, being carried to London, he put him to school at the Charter-house, whence he was removed to Merton College in Oxford. Our author left the university, which he did without taking any degree, in the full resolution to enter into the army. This step was highly displeasing to his friends; but the ardour of his passion for a military life rendered him deaf to any other proposal. Not being able to procure a better station, he entered as a private gentleman in the horse guards, notwithstanding he thereby lost the succession to his Irish estate. However, as he had a flow of good nature, a generous openness and frankness of spirit, and a sparkling vivacity of wit, these qualities rendered him the delight of the soldiery, and procured him an ensign's commission in the guards. In the mean time, as he had made choice of a profession which set him free from all the ordinary restraints in youth, he spared not to indulge his inclinations in the wildest excesses. Yet his gaieties and revels did not pass without some cool hours of reflection; it was in these that he drew up his little treatise intitled

The

Steele. *The Chriſtian Hero*, with a deſign, if we may believe himſelf, to be a check upon his paſſions. For this purpoſe it had lain ſome time by him, when he printed it in 1701, with a dedication to Lord Cutts, who had not only appointed him his private ſecretary, but procured for him a company in Lord Lucas's regiment of Fuſileers.

The ſame year he brought out his comedy called *The Funeral*, or *Grief à la Mode*. This play procured him the regard of King William, who reſolved to give him ſome eſſential marks of his favour; and though, upon that prince's death, his hopes were diſappointed, yet, in the beginning of Queen Anne's reign, he was appointed to the profitabte place of gazetteer. He owed this poſt to the friendſhip of Lord Halifax and the earl of Sunderland, to whom he had been recommended by his ſchoolfellow Mr Addiſon. That gentleman alſo lent him an helping hand in promoting the comedy called *The Tender Huſband*, which was acted in 1704 with great ſucceſs. But his next play, The Lying Lover, had a very different fate. Upon this rebuff from the ſtage, he turned the ſame humorous current into another channel; and early in the year 1709, he began to publiſh the Tatler: which admirable paper was undertaken in concert with Dr Swift. His reputation was perfectly eſtabliſhed by this work; and, during the courſe of it, he was made a commiſſioner of the ſtamp-duties in 1710. Upon the change of the miniſtry the ſame year, he joined the duke of Marlborough, who had ſeveral years entertained a friendſhip for him; and upon his Grace's diſmiſſion from all employments in 1711, Mr Steele addreſſed a letter of thanks to him for the ſervices which he had done to his country. However, as our author ſtill continued to hold his place in the ſtamp-office under the new adminiſtration, he wiſely declined the diſcuſſion of political ſubjects; and, adhering more cloſely to Mr Addiſon, he dropt the Tatler, and afterwards, by the aſſiſtance chiefly of that ſteady friend, he carried on the ſame plan, much improved, under the title of *The Spectator*. The ſucceſs of this paper was equal to that of the former; which encouraged him, before the cloſe of it, to proceed upon the ſame deſign in the character of the Guardian. This was opened in the beginning of the year 1713, and was laid down in October the ſame year. But in the courſe of it his thoughts took a ſtronger turn to politics: he engaged with great warmth againſt the miniſtry; and being determined to proſecute his views that way by procuring a ſeat in the houſe of commons, he immediately removed all obſtacles thereto. For that purpoſe he took care to prevent a forcible diſmiſſion from his poſt in the ſtamp-office, by a timely reſignation of it to the earl of Oxford; and at the ſame time gave up a penſion, which had been till this time paid him by the queen as a ſervant to the late Prince George of Denmark. This done, he wrote the famous Guardian upon the demolition of Dunkirk, which was publiſhed Auguſt 7. 1713; and the parliament being diſſolved next day, the Guardian was ſoon followed by ſeveral other warm political tracts againſt the adminiſtration. Upon the meeting of the new parliament, Mr Steele having been returned a member for the borough of Stockbridge in Hampſhire, took his ſeat accordingly in the houſe of commons; but was expelled thence in a few days after, for writing the cloſe of the paper called the *Engliſhman*, and one of his political pieces intitled the *Criſis*. Preſently after his expulſion, he publiſhed propoſals for writing the hiſtory of the duke of Marlborough; at the ſame time he alſo wrote the *Spinſter*; and, in oppoſition to the *Examiner*, he ſet up a paper called the *Reader*, and continued publiſhing ſeveral other things in the ſame ſpirit till the death of the queen. Immediately after which, as a reward for theſe ſervices, he was taken into favour by her ſucceſſor to the throne, King George I. He was appointed ſurveyor of the royal ſtables at Hampton-Court, governor of the royal company of comedians, put into the commiſſion of the peace for the county of Middleſex, and in 1715 received the honour of knighthood. In the firſt parliament of that king, he was choſen member for Boroughbridge in Yorkſhire; and, after the ſuppreſſion of the rebellion in the north, was appointed one of the commiſſioners of the forfeited eſtates in Scotland. In 1718, he buried his ſecond wife, who had brought him a handſome fortune and a good eſtate in Wales; but neither this, nor the ample additions lately made to his income, were ſufficient to anſwer his demands. The thoughtleſs vivacity of his ſpirit often reduced him to little ſhifts of wit for its ſupport; and the project of the fiſh pool this year owed its birth chiefly to the projector's neceſſities. This veſſel was intended to carry fiſh alive, and without waſting, to any part of the kingdom: but notwithſtanding all his towering hopes, the ſcheme proved very ruinous to him; for after he had been at an immenſe expence in contriving and building his veſſel, beſides the charge of the patent, which he had procured, it turned out upon trial to be a mere project. His plan was to bring ſalmon alive from the coaſt of Ireland; but theſe fiſh, though ſupplied by this contrivance with a continual ſtream of water while at ſea, yet uneaſy at their confinement, ſhattered themſelves to pieces againſt the ſides of the pool; ſo that when they were brought to market they were worth very little.

The following year he oppoſed the remarkable peerage bill in the houſe of commons; and, during the courſe of this oppoſition to the court, his licence for acting plays was revoked, and his patent rendered ineffectual, at the inſtance of the lord chamberlain. He did his utmoſt to prevent ſo great a loſs; and finding every direct avenue of approach to his royal maſter effectually barred againſt him by his powerful adverſary, he had recourſe to the method of applying to the public, in hopes that his complaints would reach the ear of his ſovereign, though in an indirect courſe, by that canal. In this ſpirit he formed the plan of a periodical paper, to be publiſhed twice a week, under the title of the *Theatre*; the firſt number of which came out on the 2d of January 1719-20. In the mean time, the miſfortune of being out of favour at court, like other miſfortunes, drew after it a train of more. During the courſe of this paper, in which he had aſſumed the feigned name of *Sir John Edgar*, he was outrageouſly attacked by Mr Dennis, the noted critic, in a very abuſive pamphlet, entitled *The Character and Conduct of Sir John Edgar*. To this inſult our author made a proper reply in the Theatre.

While he was ſtruggling with all his might to ſave himſelf from ruin, he found time to turn his pen againſt the miſchievous South-ſea ſcheme, which had nearly

brought

brought the nation to ruin in 1720; and the next year he was reſtored to his office and authority in the play-houſe in Drury-Lane. Of this it was not long before he made an additional advantage, by bringing his celebrated comedy called the *Conſcious Lovers* upon that ſtage, where it was acted with prodigious ſucceſs; ſo that the receipt there muſt have been very conſiderable, beſides the profits accruing by the ſale of the copy, and a purſe of 500l. given to him by the king, to whom he dedicated it. Yet notwithſtanding theſe ample ſupplies, about the year following, being reduced to the utmoſt extremity, he ſold his ſhare in the play-houſe; and ſoon after commenced a law-ſuit with the managers, which in 1726 was decided againſt him. Having now again, for the laſt time, brought his fortune, by the moſt heedleſs profuſion, into a deſperate condition, he was rendered altogether incapable of retrieving the loſs, by being ſeized with a paralytic diſorder, which greatly impaired his underſtanding. In theſe unhappy circumſtances, he retired to his ſeat at Languanor near Caermarthen in Wales, where he died on the 21ſt of September 1729, and was privately interred, according to his own deſire, in the church of Caermarthen. Among his papers were found the manuſcripts of two plays, one called *The Gentlemen*, founded upon the Eunuch of Terence, and the other intitled *The School of Action*, both nearly finiſhed.

Sir Richard was a man of undiſſembled and extenſive benevolence, a friend to the friendleſs, and, as far as his circumſtances would permit, the father of every orphan. His works are chaſte and manly. He was a ſtranger to the moſt diſtant appearance of envy or malevolence; never jealous of any man's growing reputation; and ſo far from arrogating any praiſe to himſelf from his conjunction with Mr Addiſon, that he was the firſt who deſired him to diſtinguiſh his papers. His great fault was want of economy; and it has been ſaid of him, he was certainly the moſt agreeable and the moſt innocent rake that ever trod the rounds of diſſipation.

STEEPLE, an appendage erected generally on the weſtern end of churches, to hold the bells. Steeples are denominated from their form, either ſpires or towers: the firſt are ſuch as aſcend continually diminiſhing either conically or pyramidally; the latter are mere parallelopipeds, and are covered a-top platform-like.

STEERAGE, on board a ſhip, that part of the ſhip next below the quarter-deck, before the bulk-head of the great cabin, where the ſteerſman ſtands, in moſt ſhips of war. See STEERING.

STEERING, in *Navigation*, the art of directing the ſhip's way by the movements of the helm; or of applying its efforts to regulate her courſe when ſhe advances.

The perfection of ſteering conſiſts in a vigilant attention to the motion of the ſhip's head, ſo as to check every deviation from the line of her courſe in the firſt inſtant of its motion; and in applying as little of the power of the helm as poſſible. By this ſhe will run more uniformly in a ſtraight path, as declining leſs to the right and left; whereas, if a greater effort of the helm is employed, it will produce a greater declination from the courſe, and not only increaſe the difficulty of ſteering, but alſo make a crooked and irregular track through the water. See HELM.—The helmſman ſhould diligently watch the movements of the head by the land, clouds, moon, or ſtars; becauſe, although the courſe is in general regulated by the compaſs, yet the vibrations of the needle are not ſo quickly perceived as the ſallies of the ſhip's head to the right or left, which, if not immediately reſtrained, will acquire additional velocity in every inſtant of their motion, and demand a more powerful impulſe of the helm to reduce them; the application of which will operate to turn her head as far on the contrary ſide of her courſe.—The phraſes uſed in ſteering a ſhip vary according to the relation of the wind to her courſe. Thus, if the wind is fair or large, the phraſes uſed by the pilot or officer who ſuperintends the ſteerage are, *port*, *ſtarboard*, and *ſteady*. The firſt is intended to direct the ſhip's courſe farther to the right; the ſecond is to guide her farther to the left; and the laſt is deſigned to keep her exactly in the line whereon ſhe advances, according to the courſe preſcribed. The exceſs of the firſt and ſecond movements is called *hard-a-port*, and *hard-a-ſtarboard*; the former of which gives her the greateſt poſſible inclination to the right, and the latter an equal tendency to the left.—If, on the contrary, the wind is foul or ſcant, the phraſes are *luff*, *thus*, and *no nearer*; the firſt of which is the order to keep her cloſe to the wind; the ſecond, to retain her in her preſent ſituation; and the third to keep her ſails full.

In a ſhip of war, the exerciſe of ſteering the ſhip is uſually divided amongſt a number of the moſt expert ſailors, who attend the helm in their turns; and are accordingly called *timoneers*, from the French term *timonier*, which ſignifies "helmſman." The ſteerage is conſtantly ſuperintended by the quarter-maſters, who alſo attend the helm by rotation. In merchant ſhips every ſeaman takes his turn in this ſervice, being directed therein by the mate of the watch, or ſome other officer.—As the ſafety of a ſhip, and all contained therein, depends in a great meaſure on the ſteerage or effects of the helm, the apparatus by which it is managed ſhould often be diligently examined by the proper officers. Indeed, a negligence in this important duty appears almoſt unpardonable, when the fatal effects which may reſult from it are duly conſidered.

STEEVENS, GEORGE, the moſt ſucceſsful of all the editors and commentators of Shakeſpeare, was born in the year 1735. We know nothing reſpecting his parents, but they appear to have been in affluent circumſtances. Our author received the rudiments of his education at Kingſton-upon-Thames, and had Gibbon the hiſtorian for a companion at that ſchool. From hence he went to Eton, and in a few years was admitted a fellow commoner of King's college, Cambridge; but no mention is made of his peculiar courſe of ſtudies. It appears, however, that he had little reliſh for the mathematics, which lead at Cambridge to academical honours. On the firſt eſtabliſhment of the Eſſex militia, he accepted of a commiſſion; but he ſpent the concluding years of his life in almoſt total ſecluſion from the world, ſeldom mingling with ſociety, but in the ſhops of bookſellers, in the Shakeſpeare gallery, or in the morning converſations of Sir Joſeph Banks.

Although not an original writer, we cannot in juſtice refuſe him a place among the firſt literary characters of the age, when we conſider the works he illuſtrated, and the learning, ſagacity, taſte, and general knowledge which he brought to the taſk. With a verſatility of talents,

lents, he was eminent both by his pen and his pencil, but his chief excellence lay in his critical knowledge of an author's text; and the beft fpecimen of his great abilities is his edition of Shakefpeare, in which he has left every competitor far behind him. He had ftudied the age of Shakefpeare, and employed his perfevering induftry in becoming acquainted with the writings, manners, and laws of that period, as well as the provincial peculiarities, whether of language or cuftoms, which prevailed in different parts of the kingdom, but more particularly in thofe where Shakefpeare paffed the early years of his life. He was continually increafing this ftore of knowledge, by the acquifition of the obfolete publications of a former age, which he fpared no expence to obtain. His critical fagacity and obfervation were conftantly employed in calling forth the hidden meanings of the dramatic bard, and of courfe enlarging the difplay of his beauties. This advantage is apparent from his laft edition of Shakefpeare, which contains fo large a portion of new, interefting, and accumulated inftruction. In preparing it for the prefs, he gave an inftance of activity and perfeverance without example. To this work he exclufively devoted a period of 18 months, during which he left his houfe every morning at one o'clock, going to his friend Mr Ifaac Read's chambers in Barnard's-inn, without any confideration of the weather or the feafon, and there he found a fheet of the Shakefpeare letter-prefs ready for correction. Thus, while the printers flept the editor was awake, by which means he completed, in lefs than 20 months, his fplendid edition of Shakefpeare in 15 vols. octavo; a labour almoft incredible, and by which the energy and perfevering powers of his mind were fully proved.

He probably refted fatisfied with being a commentator from the particular habits of his life, and his devotion to the name of Shakefpeare. But at the fame time he was a claffical fcholar of the firft order, and well acquainted with the belles lettres of Europe. He ftudied ancient and modern hiftory; and particularly that of his own country. His genius was ftrong and original; his wit abundant; his imagination of every colour; and his fentiments enlivened with the moft brilliant expreffions. His eloquence was logical and animated; his defcriptions were fo true to nature, his figures fo curioufly felected, and fo happily grouped, that he might be regarded as a fpeaking Hogarth. He fcattered his wit and his humour too freely around him, and they were not loft for want of gathering.

Mr Steevens had a very handfome fortune, which he managed with difcretion. His generofity was equal to his fortune; and though not profufe of his money to fturdy beggars, few perfons diftributed with more liberality to truly deferving objects. He poffeffed all the graces of outward accomplifhment, at a period when civility and politenefs were characteriftics of a gentleman.

He bequeathed his valuable Shakefpeare, illuftrated with about 1500 prints, to Lord Spencer; his Hogarth perfect, with the exception of one or two pieces, to Mr Windham; and his corrected copy of Shakefpeare, with 200 guineas, to his friend Mr Read. He died in the month of January 1800, about 65 years of age.

STEGANOGRAPHY, the art of fecret writing, or of writing in ciphers, known only to the perfons correfponding. See CIPHER.

STELLARIA, a genus of plants belonging to the clafs decandria, and in the natural fyftem arranged under the 22d order, *Caryophylleæ*. See BOTANY *Index*.

STELLATE, in *Botany*, a term applied to leaves which grow not lefs than fix at a joint, and are arranged like the rays of a ftar.

STELLERA, GERMAN GROUNDSEL, a genus of plants belonging to the clafs octandria; and in the natural fyftem arranged under the 31ft order, *Vepreculæ*. See BOTANY *Index*.

STELLIONATE, in the civil law, a kind of crime committed by a fraudulent bargain, where one of the parties fells a thing for what it is not; as if I fell an eftate for my own which belongs to another, or convey a thing as free and clear which is already engaged to another, or put off copper for gold, &c.

STEM, in *Botany*, that part of a plant arifing out of the root, and which fuftains the leaves, flowers, fruits, &c. By wafhing and rubbing the ftems of trees, their annual increafe is promoted; for the method of doing which, fee the article TREE.

STEM of a Ship, a circular piece of timber into which the two fides of a fhip are united at the fore-end: the lower end of it is fcarfed to the keel, and the bowfprit refts upon its upper end. The ftem is formed of one or two pieces, according to the fize of the veffel; and as it terminates the fhip forward, the ends of the wales and planks of the fides and bottom are let into a groove or channel, in the midft of its furface, from the top to the bottom; which operation is called *rabiting*. The outfide of the ftem is ufually marked with a fcale, or divifion of feet, according to its perpendicular height from the keel. The intention of this is to afcertain the draught of water at the forepart, when the fhip is in preparation for a fea-voyage, &c. The ftem at its lower end is of equal breadth and thicknefs with the keel, but it grows proportionally broader and thicker towards its upper extremity. See *SHIP-Building*.

STEMMATA, in the hiftory of infects, are three fmooth hemifpheric dots, placed generally on the top of the head, as in moft of the hymenoptera and other claffes. The name was firft introduced by Linnæus.

STEMODIA, a genus of plants belonging to the clafs didynamia; and in the natural fyftem ranging under the 40th order, *Perfonatæ*. See BOTANY *Index*.

STEMPHYLA, a word ufed by the ancients to exprefs the hufks of grapes, or the remains of the preffings of wine. The fame word is alfo ufed by fome to exprefs the remaining mafs of the olives, after the oil is preffed out.

STEMPHYLITES, a name given by the ancients to a fort of wine preffed hard from the hufks.

STEMPLES, in mining, crofs bars of wood in the fhafts which are funk to mines.

In many places the way is to fink a perpendicular hole, or fhaft, the fides of which are ftrengthened from top to bottom with wood-work, to prevent the earth from falling in; the tranfverfe pieces of wood are called *ftemples*, and by means of thefe the miners in fome places defcend, without ufing any rope.

STEMSON, in a fhip, an arching piece of timber fixed within the apron, to reinforce the fcarf thereof, in the fame manner as the apron fupports the fcarf of the ftern. In large fhips it is ufually formed of two pieces.

STENOGRAPHY (A).

CHAP. I.

THE art of ſtenography, or ſhort writing, was known and practiſed by moſt of the ancient civilized nations. The Egyptians, who were diſtinguiſhed for learning at an early period, at firſt expreſſed their words by a delineation of figures called *hieroglyphics*. A more conciſe mode of writing ſeems to have been afterwards introduced, in which only a part of the ſymbol or picture was drawn. This anſwered the purpoſe of ſhort-hand in ſome degree. After them the Hebrews, the Greeks, and the Romans *, adopted different methods of abbreviating their words and ſentences, ſuited to their reſpective languages. The initials, the finals, or radicals, often ſerved for whole words; and various combinations of theſe ſometimes formed a ſentence. Arbitrary marks were likewiſe employed to determine the meaning, and to aſſiſt legibility; and it ſeems probable that every writer, and every author of antiquity, had ſome peculiar method of abbreviation, calculated to facilitate the expreſſion of his own ſentiments, and intelligible only to himſelf.

* Vide *Buxtorf*, *Diog. Laertius*, *Plutarch*, &c.

It is alſo probable, that ſome might by theſe means take down the heads of a diſcourſe or oration; but few, very few, it is preſumed, could have followed a ſpeaker through all the meanders of rhetoric, and noted with preciſion every ſyllable, as it dropt from his mouth, in a manner legible even to themſelves.

To arrive at ſuch conſummate perfection in the art was reſerved for more modern times, and is ſtill an acquiſition by no means general.

In every language of Europe, till about the cloſe of the 16th century, the Roman plan of abbreviating (viz. ſubſtituting the initials or radicals, with the help of arbitraries, for words) appears to have been employed. Till then no regular alphabet had been invented expreſsly for ſtenography, when an Engliſh gentleman of the name of *Willis* invented and publiſhed one (B). His plan was ſoon altered and improved, or at leaſt pretended to be ſo. One alteration ſucceeded another; and at intervals, for a ſeries of years paſt, ſome men of ingenuity and application have compoſed and publiſhed ſyſtems of ſtenography, and doubtleſs have themſelves reaped all the advantages that attend it. But among the various methods that have been propoſed, and the different plans that have been adopted by individuals, none has yet appeared fortunate enough to gain general approbation; or proved ſufficiently ſimple, clear, and conciſe, to be univerſally ſtudied and practiſed.

Some ſyſtems are replete with unmeaning ſymbols, perplexing arbitraries, and ill-judged contractions; which render them ſo difficult to be attained by a common capacity, or ordinary application, that it is not to be wondered at if they have ſunk into neglect, and are now no longer known (C). Other ſyſtems, by being too prolix, by containing a multiplicity of characters, and thoſe characters not ſimple or eaſily remembered, become ineffectual to the purpoſe of expedition, and are only ſuperior in obſcurity to a common hand. Some, again, not only reject all arbitraries and contractions, but even prepoſitions and terminations; which laſt, if not too laviſhly employed and badly deviſed, highly contribute to promote both expedition and legibility; and though they reduce their characters to fewer than can poſſibly expreſs the various modifications of ſound, yet they make nearly one half of them complex. In the diſpoſition of the vowels, there is the greateſt perplexity in moſt ſyſtems. A dot is ſometimes ſubſtituted for all the vowels indiſcriminately, and the judgement is left to determine which letter out of ſix any dot is intended to expreſs; or a minute ſpace is allotted them; ſo that unleſs they be arranged with mathematical preciſion they cannot be diſtinguiſhed from one another; but ſuch a minute attention is inconſiſtent with the nature of ſhort-hand, which ſhould teach us to write down in a ſhort time, as well as in ſmall bounds, what we wiſh to preſerve of what we hear. Nor is the plan of lifting the pen and putting the next conſonant in the vowel's place, in the middle of words, leſs liable to objections; or that of repreſenting all the vowels by diſtinct characters, being obviouſly ill calculated for facility and diſpatch,

(A) The value of ſtenography is not unknown to the learned; and the care and ſucceſs with which it has been lately cultivated in theſe kingdoms will, in all probability, ſoon render it an object of general attention. No one, however, appears to us to have ſimplified and improved the art ſo much as Dr Mavor, author of *Univerſal Stenography*, who has liberally permitted us to preſent our readers with a complete view of his ſcheme. To thoſe who wiſh to become proficients in SHORT-WRITING, we earneſtly recommend his entire publication (printed for Cadell and Davis, Strand, London), which in many ſchools of the firſt reputation now forms a deſerved claſs-book.

(B) Mr Locke ſays, a regular method of ſhort-writing ſeems to be known and practiſed only in Britain. This is not now the caſe; and indeed there is no reaſon to doubt whether characters may not be invented to expreſs the various ſounds, or letters, employed in any language, either ancient or modern.

(C) A liſt of writers on ſtenography. Mr Addy, Alridge, Angell, Annet, Blandemore, Bloſſet, Botley, Bridges, Byrom, Coles, Croſs, Dix, Everardt, Ewen, Facey, Farthing, Gibbs, Græme, Gurney, Heath, Holdſworth, Hopkins, Jeake, Labourer, Lane, Lyle, Macauley, Maſon, Mavor, Metcalfe, Nicholas, Palmer, Rich, Ridpath, Shelton, Steele, Tanner, Taylor, Thickneſſe, Tiffen, Webſter, Weſton, Williamſon, Willis, B. D. and Willis, &c.

diſpatch, and conſequently inadmiſſible into any uſeful ſyſtem.

It is to be confeſſed, that the perſon who firſt propoſed the omiſſion of vowels in the middle of words (D), which it is obvious are not wanted, and invented letters, which could be connected as in a running hand without lifting the pen in the middle of the word, made a real improvement on the works of his predeceſſors. But, in fine, moſt ſyſtems, either in their plan or execution, labour under ſome capital defect, attended with circumſtances highly diſcouraging to the learner, and which in a great meaſure defeat the end of their invention, by being too complicated to be learned with eaſe and remembered with accuracy, or to be practiſed with the expedition which is requiſite; and ſo difficult to be deciphered, that a man can ſcarcely read what he has juſt written.

To obviate theſe defects; to provide againſt prolixity and conciſeneſs, which might occaſion obſcurity; to exhibit a ſyſtem founded on the ſimpleſt principles, which might be eaſily learned and read, and yet be capable of the utmoſt expedition—were the motives that gave riſe to the preſent attempt.

This method will be found different from any yet publiſhed, and ſuperior to all in the diſpoſition of the vowels and the facility of arranging them; the confuſion in placing which ſeems to detract from the merit of the beſt performances on the ſubject; and it may be affirmed, without oſtentation, that characters ſimpler in their form, and more perfect in their union, have not been applied to the art of ſtenography.

As well as it could be determined, the ſimpleſt characters are appropriated to the letters moſt uſually employed: indeed, as far as poſſible, thoſe which are complex have been rejected; but as it was an object always kept in view that the writing ſhould be on a line, a few are admitted into the alphabet for that reaſon.

The characters for the double and triple conſonants are the eaſieſt that could be invented, conſiſtent with perſpicuity (E); for care has been taken to provide againſt all obſcurity which might ariſe by adopting letters too ſimilar in their formation; and with reſpect to the prepoſitions and terminations, thoſe which occur moſt frequently are expreſſed by the ſimpleſt characters, which will be found perfectly eaſy in their application.

The arbitraries are few in number (F), and the arbitrary abbreviations, as they are entirely from the letters of the alphabet, and choſen from ſome thouſands of words in common uſe, will well repay the learner for an hour's trouble in committing them to memory.

The laſt chapter lays down a ſcheme of abbreviation, compriſed in a few rules, perfectly eaſy to be underſtood and practiſed by proficients in this art, which we hope will anſwer the expectation of the author, and will be found free from the perplexity complained of in many ſyſtems where abbreviation is admitted. The principal rules are new, are ſo eaſy, ſo extenſive in their uſe, and ſo conſiſtent with expedition and legibility, if applied with judgement, that they alone might ſuffice. The learner is however adviſed by no means to adopt any of them, till experience has convinced him that they may be uſed without error or injury to legibility. All abbreviating rules are ſuited to thoſe only who have made ſome progreſs in the ſtenographic art; for although they certainly promote expedition in a wonderful manner, and afford the greateſt eaſe to a proficient, yet a learner, as expedition is not his firſt, though his ultimate view, ſhould admit of nothing that in the leaſt renders the reading difficult.

CHAP. II.

THE Engliſh alphabet conſiſts of twenty-ſix letters; ſix of which are vowels, *a*, *e*, *i*, *o*, *u*, and *y*; and the other twenty conſonants, *b*, *c*, *d*, *f*, *g*, *h*, *k*, *l*, *m*, *n*, *p*, *q*, *r*, *s*, *t*, *v*, *x*, and *z*. 1 The general principles of ſtenography.

This alphabet, as is obſerved by the beſt grammarians that have written on the language, is both defective and redundant in expreſſing the various modifications of ſound *.

* *Lowth's Gram. Prieſtley's Gram. Sheridan's Lectures on Elocution.*

Cuſtom or prejudice has aſſigned ſome letters a place, when others would with much more propriety expreſs the ſame ſound: and to this may be added, that ſeveral letters, ſometimes in one word, ſeem to be admitted for no other reaſon than to perplex a young beginner or a foreigner, as an obſtruction to true pronunciation, and to add to the apparent length of the word, when they are entirely quieſcent and uſeleſs. That this is the genius of the orthography of our language muſt be perceived by the moſt ſuperficial obſerver; but no modern tongue is abſolutely free from the ſame exceptions. In particular, the French has a great number of dormant letters, which, it is obvious, render the pronunciation more difficult and perplexing to learners (G).

But as it is neither our buſineſs nor our intention to propoſe a mode of ſpelling different from that in common uſe, when applied to printing or long-hand writing (ſince ſeveral innovators in orthography have fallen into contempt, and their plans have been only preſerved as beacons to warn others of the folly of endeavouring to ſubvert eſtabliſhed principles †); we ſhall only obſerve, that in ſtenography, where the moſt expeditious and conciſe

† *Preface to Johnſon's Dictionary.*

(D) Mr Byrom rejected vowels entirely in the middle of words, as others before him had only done partially. Without critically examining the executive part of his performance, which is very defective, it muſt be owned, that it is above the reach of human ingenuity to exceed his general plan; which for ever muſt be the baſis of every future rational ſyſtem.

(E) Thoſe for *th* and *ch* may be either made upright or ſloping to the right.

(F) Theſe are not by any means preſcribed; they may be employed or not according to the fancy of the learner.

(G) The Latin and Greek claim a juſt ſuperiority over every modern tongue in this reſpect. In them no confuſion or doubt can ariſe from the manner of ſpelling; and the reader can ſcarcely be wrong (unleſs in quantity) in ſounding all the letters he ſees.

conciſe method is the beſt, if conſiſtent with perſpicuity, the following ſimple rules are ſtudiouſly to be regarded and practiſed.

2 Rules for the conſonants.

RULE I. All quieſcent conſonants in words are to be dropped; and the orthography to be directed only by the pronunciation: which being known to all, will render this art attainable by thoſe who cannot ſpell with preciſion in long hand.

RULE II. When the abſence of conſonants, not entirely dormant, can be eaſily known, they may often be omitted without the leaſt obſcurity.

RULE III. Two or ſometimes more conſonants may, to promote greater expedition, be exchanged for a ſingle one of nearly ſimilar ſound; and no ambiguity as to the meaning enſue (H).

RULE IV. When two conſonants of the ſame kind or ſame ſound come together, without any vowel between them, only one is to be expreſſed; but if a vowel or vowels intervene, both are to be written: only obſerve, if they are perpendicular, horizontal, or oblique lines, they muſt only be drawn a ſize longer than uſual; and characters with loops muſt have the ſize of their heads doubled *.

* See Plate DVII.

3 Firſt rule exemplified.

Might is to be written *mit*, fight *fit*, machine *maſhin*, enough *enuf*, laugh *laf*, prophet *profet*, phyſics *fiſiks*, through *thro'*, foreign *foren*, ſovereign *ſoveren*, pſalm *ſam*, receipt *reſet*, write *rite*, wright *rit*, iſland *iland*, knavery *navery*, temptation *temtation*, knife *nife*, ſtick *ſtik*, thigh *thi*, honour *onour*, indictment *inditement*, acquaint *aquaint*, chaos *kaos*, &c.

4 Second rule exemplified.

Strength *ſtrenth*, length *lenth*, friendſhip *frenſhip*, connect *conek*, commandment *comanment*, conjunct *conjunt*, humble *humle*, lumber *lumer*, ſlumber *ſlumer*, number *numer*, exemplary *exemlary*, &c.

5 Third rule exemplified.

Rocks *rox*, acts *aks* or *ax*, facts *faks* or *fax*, diſtricts *diſtriks*, or *diſtrix*, affects *afeks* or *afex*, afflicts *afliks* or *aflix*, conquer *konkr*, &c.

6 Fourth rule exemplified.

Letter *leter*, little *litle*, command *comand*, error *eror*, terror *teror*, &c. But in *remember*, *moment*, *ſiſter*, and ſuch like words, where two conſonants of the ſame name have an intervening vowel, both of them muſt be written.

Theſe four rules, with their examples, being carefully conſidered by the learner, will leave him in no doubt concerning the diſpoſition and management of the conſonants in this ſcheme of ſhort-writing; we ſhall therefore proceed to lay down rules for the application of the vowels with eaſe and expedition.

7 Rules for the vowels.

RULE I. Vowels, being only ſimple articulate ſounds, though they are the connectives of conſonants, and employed in every word and every ſyllable, are not neceſſary to be inſerted in the middle of words; becauſe the conſonants, if fully pronounced, with the aſſiſtance of connection, will always diſcover the meaning of a word, and make the writing perfectly legible.

RULE II. If a vowel is not ſtrongly accented in the incipient ſyllable of a word, or if it is mute in the final, it is likewiſe to be omitted; becauſe the ſound of the incipient vowel is often implied in that of the firſt conſonant, which will conſequently ſupply its place.

RULE III. But if the vowel conſtitutes the firſt or laſt ſyllable of a word, or is ſtrongly accented at its beginning or end, that vowel is continually to be written.

RULE IV. If a word begins or ends with two or more vowels though ſeparated, or when there is a coalition of vowels, as in diphthongs and triphthongs; only one of them is to be expreſſed, which muſt be that which agrees beſt with the pronunciation.

RULE V. In monoſyllables, if they begin or end with a vowel, it is always to be inſerted, unleſs the vowel be *e* mute at the end of a word.

Such are the general principles of this art; in vindication and ſupport of which it will be needleſs to offer any arguments, when it is conſidered that brevity and expedition are the chief objects, if conſiſtent with legibility; and the ſubſequent ſpecimens in the orthography recommended will, we hope, be ſufficient to ſhow that there is no real deficiency in the laſt-mentioned particular.

8 Specimen of the mode of ſpelling in ſtenography.

He who md us mſt be etrnl, grt, nd mnptnt. It is or dty, as rſnl bngs, to ſrv, lv, nd oby hm.—A mn tht wd avd blm, ſhd be ſrkmſpk in al hs axns, nd ndvr wth al hs mt to pls evry bdy.—I wd nt frm any knxns wth a mn who hd no rgrd fr hmslf; nthr wd I blv a mn who hd ons tld me a li.—Onr is of al thngs the mſt dfklt to prſrv ntrnſhd; nd whn ons mpchd, lk the chſty of a wmn, nvr ſhns wth its wntd lſtr.—Wth gd mnrs, kmplſms nd an eſy plt adrs, mny mk a fgr in the wrl, whs mnl ablts wd ſkrſly hv rsd thm aby the rnk of a ſtmn.—Idlns is the prnt of a thſnd msfrtns, wch ar nvr flt by the ndſtrs: it is a pn nd a pnſhmnt of itslf, nd brngs wnt nd bgry in its trn.—Vrtu is the frſt thng tht ſhd be rgrdd; it is a rwrd of itslf; mks a mn rſpktbl hr, nd wl mk hm etrnly hpy hrftr.—Prd is a mſt prnſs psn, wch yt ws plntd by hvn in ur ntr, to rs ur emlsn to imtt grt nd wrthy krktrs or axns, to xt in us a sl fr wht is rt nd gſt, nd a ldbl ndgnſn gnſt oprſrs nd wrks of any knd of nkyty; in ſhrt, to mk us st a prpr vlu upn urvſls, nd dſps a wrthls flo, hu evr xltd. Ths fr prd is a vrtu, nd my gſtly be kld a grtns of ſl. Bt prd, lk othr pſns, gnrly fxs upon rng obgks, or is apld in rng prprſns. Hu kmn is it to ſe a rtch whm evry vs hs rndrd mſrbl, nd evry fly kntmtbl, vlng hmſlf on hs hi brth, nd bſtng ths ilſtrs nſttrs, of whm he nhrts nthng bt the nm or ttl! nſtrs who if thy nu hm, wd dſn thr dſndnt wth kntmt. But al prd of ths ſrt is fly, nd evr to be avdd.

CHAP. III.

As the whole of this art depends upon a regular method and a ſimple alphabet, we have not only endeavoured to eſtabliſh the former on ſatisfactory principles, but have been careful to appropriate, according to the comparative frequency of their occurrence, ſuch characters

(H) By this rule likewiſe *q* and *v* in the middle of words, but never in the beginning, may be exchanged for *k* and *f*, when they admit of an eaſier connecting with the following character, or will make the writing appear neater.

ters for the letters as, after repeated trials and alterations, were conceived to be the beſt adapted for diſpatch.

9 Stenographic alphabet. Plate DVII.

The ſtenographic alphabet conſiſts of 18 diſtinct characters (viz. two for the vowels and the reſt for the conſonants), taken from lines and ſemicircular curves; the formation and application of which we ſhall now explain, beginning with the vowels.

For the three firſt vowels, *a*, *e*, and *i*, a comma is appropriated in different poſitions; and for the other three, *o*, *u*, and *y*, a point. The comma and point, when applied to *a*, and *o*, is to be placed, as in the Plate DVII. at the top of the next character; when for *e* and *u*, oppoſite to the middle; and when for *i* and *y*, at the bottom.

This arrangement of the vowels is the moſt ſimple and diſtinct that can eaſily be imagined. Places at the top, the middle, and the bottom of characters, which make three different poſitions, are as eaſily diſtinguiſhed from one another as any three ſeparate characters could be; and a comma is made with the ſame facility as a point.

10 Lines.

Simple lines may be drawn four different ways; perpendicular, horizontal, and with an angle of about 45 degrees to the right and left. An aſcending oblique line to the right, which will be perfectly diſtinct from the reſt when joined to any other character, may likewiſe be admitted. Theſe characters being the ſimpleſt in nature, are aſſigned to thoſe five conſonants which moſt frequently occur, viz. *l*, *r*, *t*, *c* hard or *k*, and *c* ſoft or *s*.

11 Circles.

Every circle may be divided with a perpendicular and horizontal line, ſo as to form likewiſe four diſtinct characters. Theſe being the next to lines in the ſimplicity of their formation, we have appropriated them for *b*, *d*, *n*, and *m*.

12 Curves and lines.

The characters expreſſing nine of the conſonants are all perfectly diſtinct from one another; eight only remain which are needful, viz. *f*, *g* or *j*, *h*, *p*, *q*, *v*, *w*, and *x*; to find characters for which we muſt have recourſe to mixed curves and lines. The characters which we have adopted are the ſimpleſt in nature after thoſe already applied, admit of the eaſieſt joining, and tend to preſerve lineality and beauty in the writing.

It muſt be obſerved that we have no character for *c* when it has a hard ſound, as in *caſtle*; or ſoft, as in *city*; for it naturally takes the ſound of *k* or *s*, which in all caſes will be ſufficient to ſupply its place.

R likewiſe is repreſented by the ſame character as *l*; only with this difference, *r* is written with an aſcending ſtroke (I), and *l* with a deſcending; which is always to be known from the manner of its union with the following character; but in a few monoſyllables where *r* is the only conſonant in the word, and conſequently ſtands alone, it is to be made as is ſhown in the alphabet for diſtinction's ſake.

Z, as it is a letter ſeldom employed in the Engliſh language, and only a coarſer and harder expreſſion of *s*, muſt be ſupplied by *s* whenever it occurs; as for *Zedekiah* write *Sedekiah*, &c.

CHAP. IV.

13 Rules for prepoſitions and terminations.

The prepoſitions and terminations in this ſcheme are ſo ſimple, that the greateſt benefit may be reaped from them, and very little trouble required to attain them; as the incipient letter or the incipient conſonant of all the prepoſitions and of ſeveral of the terminations is uſed to expreſs the whole. But although in Plate DVII. ſufficient ſpecimens are given of the manner of their application, that the learner of leſs ingenuity or more ſlow perception may have every aſſiſtance, we have ſubjoined the following directions.

Rule I. The prepoſition is always to be written without joining, yet ſo near as plainly to ſhow what word it belongs to; and the beſt way is to obſerve the ſame order as if the whole was to be connected.

Rule II. A prepoſition, though the ſame letters that conſtitute it may be met with in the middle or end of a word, is never to be uſed, becauſe it would expoſe to obſcurity.

Rule III. Obſerve that the prepoſition *omni* is expreſſed by the vowel *o* in its proper poſition; and for *anti*, *anta*, *ante*, by the vowel *a*, which the radical part of the word will eaſily diſtinguiſh from being only ſimple vowels.

The firſt rule for the prepoſitions is (allowing ſuch exceptions as may be ſeen in the Plate) to be obſerved for the terminations; and alſo the ſecond, *mutatis mutandis*; except that whenever *ſis*, *ſus*, *ſys*, *cious*, *tious*, and *ces* occur, they are to be expreſſed as directed in the fourth rule for the conſonants, whether in the beginning, middle, or end of words (K).

Rule IV. The terminative character for *tion*, *ſion*, *cion*, *cian*, *tian*, is to be expreſſed by a ſmall circle joined to the neareſt letter, and turned to the right; and the plurals *tions*, *ſions*, *cions*, *cians*, *tians*, *tience*, by a dot on the ſame ſide.

Rule V. The terminative character for *ing*, is to be expreſſed likewiſe by a ſmall circle, but drawn to the left hand; and its plural *ings* by a dot (L).

Rule VI. The plural ſign *s* is to be added to the terminative characters when neceſſary.

Rule VII. The ſeparated terminations are never to be uſed but in polyſyllables or words of more ſyllables than one.

Theſe rules duly obſerved will point out a method as conciſe and elegant as can be deſired, for expreſſing the moſt

(I) The character for *h*, when lineality requires it, may be made from the bottom and inverted (ſee Plate DVII.) And often *h* may be omitted entirely, or a vowel may be ſubſtituted in its ſtead, without any injury to legibility, it being rather a breathing than letter.

(K) But in a few words where three horizontal characters meet, it will be better to expreſs the *ſis*, &c. by the ſemielliptical character in Plate DVII. oppoſite *tious*.

(L) In horizontal characters, by the left hand is meant the top, and by the right the ſpace below the letter (ſee *ing* joined, Plate DVII.). In all other characters the right and left poſitions will naturally be known.

moſt frequent and longeſt prepoſitions and terminations in the Engliſh language. If it ſhould be thought neceſſary to increaſe their number by the addition of others, it will be an eaſy matter for any one of the leaſt diſcernment to do ſo, by proceeding on the principles before laid down.

CHAP. V.

14 Rules for abbreviation. THOUGH a more conciſe method of writing, or more numerous abbreviations, may not be indiſpenſably neceſſary, if the foregoing directions be practiſed for a conſiderable time, yet contractions will be found extremely uſeful and convenient to thoſe who have attained a proper knowledge of the ſubject, and lead to a greater degree of expedition, at the ſame time that they diminiſh the labour of writing. It has been obſerved in the introduction, that abbreviations are only to be employed by proficients in this art; becauſe expedition is not the firſt, though the ultimate, object in view; and that an eaſy legibility is of the utmoſt conſequence to the learner; which, however, cannot be preſerved, if he adopts too ſoon thoſe very rules which in time will afford him the greateſt eaſe when applied with judgement.

The following ſhort and practical rules will be found, we hope, fully adequate to every purpoſe for which they were intended, and are far ſuperior in the facility of their application to any which we have ſeen.

RULE I. The uſual abbreviations in long hand are always to be followed; as Mr for Maſter, M. D. for Doctor of Phyſic, and Abp. for Archbiſhop, &c.

RULE II. Subſtantives, adjectives, verbs, and participles, when the ſenſe will direct to the meaning, are to be expreſſed by their initial conſonant with the diſtinguiſhing marks exhibited in Plate DVII. viz. a ſubſtantive muſt have the dot exactly over its initial conſonant; an adjective muſt have a dot under it; a verb is to be expreſſed by a comma over its initial conſonant; and a participle by a comma under (M). Theſe being the four principal parts of ſpeech will be ſufficient; and an adept will never be at a loſs to know when he can with ſafety apply this rule to them.

RULE III. To render the writing more legible, the laſt letter of the word may be joined to the firſt, and the proper mark applied.

RULE IV. The conſtituent or radical part of words, eſpecially if they are long, will often ſerve for the whole, or ſometimes the firſt ſyllable: as, we ought to moderate our *ex.* by our *circum.*; a man's *man.* commonly ſhape his *for.*

RULE V. All long words without exception may have their prepoſitions or terminations expreſſed by the incipient conſonant of ſuch prepoſition or termination.

RULE VI. When there is a great dependence between the parts of a ſentence, the initial letter will often ſuffice; as *L.* is the capital of Great *B.*; the eldeſt *S.* of the king of Great *B.* is ſtyled prince of *W.* Every one, it is preſumed, will allow this to be perfectly legible in long-hand, then why may it not in ſtenography?

RULE VII. The terminations *neſs* and *leſs* may be omitted; as *faithfulneſs* is only to be written *faithful*; *forwardneſs*, *forward*; *heedleſs*, *heed*; *ſtubbornneſs*, *ſtubborn*, &c.

RULE VIII. The ſecond and third perſons of verbs, ending in *eth* and *eſt*, may be expreſſed by *s*; as, he *loves*, thou *teaches*; inſtead of he *loveth*, thou *teacheſt*: or even without *s*; as, he *love*, &c.

RULE IX. Words may often be entirely omitted, and yet no ambiguity enſue; as, *In beginning God created heaven and earth*, for In *the* beginning God created *the* heaven and *the* earth.

RULE X. When there is an immediate repetition of a ſentence or word, a line is to be drawn under the ſentence or word to be repeated; as, Amen, Amen, is to be written *Amen*; but if any words intervene before a word or ſentence is to be repeated, the line muſt be drawn as before, and a ʌ or mark of omiſſion placed where the repetition ſhould begin; as, *Is it juſt the innocents ſhould be* condemned ʌ reviled?

The CONTENTS of the STENOGRAPHIC PLATES.

Fabricius's Reply to Pyrrhus.

As to my poverty, you have indeed, Sir, been rightly informed. My whole eſtate conſiſts in a houſe of but mean appearance, and a little ſpot of ground, from which by my own labour I draw my ſupport. But if by any means you have been perſuaded to think, that this poverty makes me leſs conſidered in my country, or in any degree unhappy, you are extremely deceived. I have no reaſon to complain of fortune, ſhe ſupplies me with all that nature requires; and if I am without ſuperfluities, I am alſo free from the deſire of them. With theſe I confeſs I ſhould be more able to ſuccour the neceſſitous, the only advantage for which the wealthy are to be envied; but as ſmall as my poſſeſſions are, I can ſtill contribute ſomething to the ſupport of the ſtate and the aſſiſtance of my friends. With regard to honours, my country places me, poor as I am, upon a level with the richeſt: for Rome knows no qualifications for great employments but virtue and ability. She appoints me to officiate in the moſt auguſt ceremonies of religion; ſhe entruſts me with the command of her armies; ſhe confides to my care the moſt important negotiations. My poverty does not leſſen the weight and influence of my counſels in the ſenate; the Roman people honour me for that very poverty which you conſider as a diſgrace; they know the many opportunities I have had in war to enrich myſelf without incurring cenſure; they are convinced of my diſintereſted zeal for their proſperity; and if I have any thing to complain of in the return they make, it is only the exceſs of their applauſe. What value then can I ſet upon your gold and ſilver! What king can add any thing to my fortune! Always attentive to diſcharge the duties incumbent

Plate DVIII.

(M) The dot or comma being placed thus will never occaſion them to be miſtaken for vowels, becauſe they ſhould always be on one ſide or other; whereas the mark for parts of ſpeech may conſtantly be placed exactly over or under.

incumbent on me, I have a mind free from ſelf-reproach, and I have an honeſt fame. *Dodſley's Preceptor.*

Letter to a Friend againſt waſte of Time.

Converſe often with yourſelf, and neither laviſh your time, nor ſuffer others to rob you of it. Many of our hours are ſtolen from us, and others paſs inſenſibly away; but of both theſe loſſes the moſt ſhameful is that which happens through our own neglect. If we take the trouble to obſerve, we ſhall find that one conſiderable part of our life is ſpent in doing evil, and the other in doing nothing, or in doing what we ſhould not do. We don't ſeem to know the value of time, nor how precious a day is; nor do we conſider that every moment brings us nearer our end. Reflect upon this, I entreat you, and keep a ſtrict account of time. Procraſtination is the moſt dangerous thing in life. Nothing is properly ours but the inſtant we breathe in, and all the reſt is nothing; it is the only good we poſſeſs; but then it is fleeting, and the firſt comer robs us of it. Men are ſo weak, that they think they oblige by giving of trifles, and yet reckon that time as nothing for which the moſt grateful perſon in the world can never make amends. Let us therefore conſider time as the moſt valuable of all things; and every moment ſpent, without ſome improvement in virtue or ſome advancement in goodneſs, as the greateſt ſublunary loſs.

St Paul's Speech before Agrippa and Feſtus.

I think myſelf happy, King Agrippa, that I ſhall anſwer for myſelf this day before thee, touching all things whereof I am accuſed of the Jews: eſpecially becauſe I know thee to be expert in all cuſtoms and queſtions which are among the Jews, wherefore I beſeech thee to hear me patiently. My manner of life from my youth, which was at firſt among mine own nation at Jeruſalem, know all the Jews, which knew me from the beginning (if they would teſtify), that, after the ſtraiteſt ſect of our religion I lived a Phariſee. And now I ſtand and am judged for the hope of the promiſe made by God unto our fathers: unto which promiſe our twelve tribes inſtantly ſerving God day and night hope to come; for which hope's ſake, King Agrippa, I am accuſed of the Jews. Why ſhould it be thought a thing incredible with you, that God ſhould raiſe the dead, when God himſelf has given aſſurance of it unto all men, in that he hath raiſed Chriſt from the dead? As for my own part, moſt noble Feſtus, I own I once verily thought that even I myſelf ought to do many things contrary to the name of Jeſus of Nazareth. Which thing I alſo did in Jeruſalem. I puniſhed the ſaints oft in every ſynagogue, and compelled them to blaſpheme; and being exceedingly mad againſt them, I perſecuted them even unto ſtrange cities. In purſuit of which, as I went to Damaſcus, with authority and commiſſion from the chief prieſts: At mid-day, O king, I ſaw in the way a light from heaven, above the brightneſs of the ſun, ſhining about me, and them which journeyed with me. And when we were all fallen to the earth, I heard a voice ſpeaking unto me, and ſaying in the Hebrew tongue, Saul, Saul, why perſecuteſt thou me? It is hard for thee to kick againſt the pricks. And I ſaid, Who art thou, Lord? And he ſaid, I am Jeſus whom thou perſecuteſt. But riſe, and ſtand upon thy feet: for I have appeared unto thee for this purpoſe, to make thee a miniſter and a witneſs both of theſe things which thou haſt ſeen, and of thoſe things in which I will appear unto thee. Whereupon, O king Agrippa, I was not diſobedient to the heavenly viſion: but ſhewed firſt unto them of Damaſcus, and at Jeruſalem, and throughout all the coaſts of Judea, and then to the Gentiles, that they ſhould repent and turn to God. For theſe cauſes the Jews caught me in the temple, and went about to kill me. Having therefore obtained help of God, I continue unto this day, witneſſing both to ſmall and great, ſaying none other things than thoſe which the prophets and Moſes did ſay ſhould come: That Chriſt ſhould ſuffer, and that he ſhould be the firſt that ſhould riſe from the dead, and ſhould ſhow light unto the people, and to the Gentiles. This is the real truth: Believe me, I am no peſtilent fellow, nor mover of ſedition; but always endeavour all that lies in me to preſerve a conſcience void of offence towards God and towards man: nor can the Jews prove the things whereof they now accuſe me. Neither am I, Feſtus, beſides myſelf; but ſpeak thus freely before the king, becauſe he knows theſe things to be fact; yea, I am fully perſuaded the king knows them all to be fact; for they were not done in a corner. King Agrippa, believeſt thou the prophets? I know that thou believeſt. And would to God that not only thou, but alſo all that hear me this day, were altogether ſuch as I am except theſe bonds. *Holmes's Rhetoric.*

Pope to Atterbury.

Once more I write to you as I promiſed, and this once I fear will be the laſt; the curtain will ſoon be drawn between my friend and me, and nothing left but to wiſh you a long good night; may you enjoy a ſtate of repoſe in this life not unlike that ſleep of the ſoul which ſome have believed is to ſucceed it, where we lie utterly forgetful of that world from which we are gone, and ripening for that to which we are to go. If you retain any memory of the paſt, let it only image to you what has pleaſed you beſt; ſometimes preſent a dream of an abſent friend, or bring you back an agreeable converſation. But, upon the whole, I hope you will think leſs of the time paſt than the future; as the former has been leſs kind to you than the latter infallibly will be. Do not envy the world your ſtudies: They will tend to the benefit of men, againſt whom you can have no complaint; I mean, of all poſterity: and, perhaps, at your time of life, nothing elſe is worth your care. What is every year of a wiſe man's life but a cenſure or critic on the paſt? Thoſe whoſe date is the ſhorteſt, live long enough to laugh at one half of it: The boy deſpiſes the infant, the man the boy, the philoſopher both, and the Chriſtian all. You may now begin to think your manhood was too much a puerility; and you will never ſuffer your age to be but a ſecond infancy. The toys and baubles of your childhood are hardly now more below you than thoſe toys of our riper and our declining years; the drums and rattles of ambition, and the dirt and bubbles of avarice. At this time, when you are cut off from a little ſociety, and made a citizen of the world at large, you ſhould bend your talents not to ſerve a party, or a few, but all mankind. Your genius ſhould mount above that miſt, in which its participation and neighbourhood with earth hath long involved it: To ſhine abroad, and to heaven, ought

ought to be the bufinefs and the glory of your prefent fituation. Remember it was at fuch a time that the greateft lights of antiquity dazzled and blazed the moft; in their retreat, in their exile, or in their death. But why do I talk of dazzling or blazing? it was then that they did good, that they gave light, and that they became guides to mankind. Thofe aims alone are worthy of fpirits truly great, and fuch I therefore hope will be yours. Refentment indeed may remain, perhaps cannot be quite extinguifhed, in the nobleft minds; but revenge will never harbour there: Higher principles than thofe of the firft, and better principles than thofe of the latter, will infallibly influence men whofe thoughts and whofe hearts are enlarged, and caufe them to prefer the whole to any part of mankind, efpecially to fo fmall a part as one's fingle felf. Believe me, my Lord, I look upon you as a fpirit entered into another life, as one juft upon the edge of immortality, where the paffions and affections muft be much more exalted, and where you ought to defpife all little views and all mean retrofpects. Nothing is worth your looking back: and therefore look forward, and make (as you can) the world look after you; but take care it be not with pity, but with efteem and admiration. I am, with the greateft fincerity and paffion for your fame as well as happinefs, your, &c.

The above moft charming and moft affectionate letter was written about a month before Atterbury bifhop of Rochefter was fent into banifhment, and is univerfally admired.

STENTOROPHONIC TUBE, a fpeaking trumpet; thus called from Stentor, a perfon mentioned by Homer. See TRUMPET.

STEP, in a fhip, a block of wood fixed on the decks or bottom of a fhip, and having a hole in its upper fide, fitted to receive the heel of a maft or capftern. The fteps of the main and foremafts of every fhip reft upon the kelfon, to which they are firmly fecured by knees, bolts, or fpike-nails. The ftep of the mizen-maft ufually refts upon the lower deck.

STEPHANIUM, a genus of plants belonging to the pentandria clafs; and in the natural method ranking under the 47th order, *Stellatæ*. See BOTANY *Index*.

STEPHANOPHORUS, in antiquity, the chief prieft of Pallas, who prefided over the reft. It was ufual for every god to have a chief prieft; that of Pallas was the Stephanophorus juft mentioned, and that of Hercules was called Dadouchus.—Stephanophorus was alfo a prieft who affifted the women in the celebration of the feftival Thefmophoria.

STEPHANUS BYZANTINUS, an able grammarian, who lived in the fifth or fixth century. He wrote a Dictionary, in which he made a great number of obfervations, borrowed from mythology and hiftory, which fhowed the origin of cities and colonies, of which we have nothing remaining but a mean abridgement by Hermolaus the grammarian; but from that work the learned have received great light; and Sigonius, Cafaubon, Scaliger, Salmafius, &c. have employed themfelves in illuftrating it.

STEPHEN, king of England. See ENGLAND, N° 108, &c.

STEPHEN, or *St Stephen's Day*, a feftival of the Chriftian church, obferved on the 26th of December, in memory of the firft martyr St Stephen.

STEPHENS, a family of printers defervedly celebrated. They flourifhed at the time of the revival of learning, and contributed a great deal towards difpelling the cloud of ignorance which had fo long overfhadowed Europe. Some of the claffics before the 16th century were in a great meafure loft, and all of them were exceedingly corrupted. By their abilities and indefatigable induftry thefe defects were fupplied, and the learned were furnifhed with beautiful and correct editions of the Greek and Roman authors. Thus the world was not only fupplied with an inexhauftible fund of amufement and inftruction in thefe ancient writings; but it is to the ardour which they infpired, and to the model of elegance which they difplayed, that the prefent advanced ftate of literature is in a great meafure owing.

HENRY STEPHENS, the firft of thefe illuftrious men, was born in France, foon after the difcovery of printing, perhaps about the year 1465. He fettled as a printer at Paris, and was probably patronized by Louis XII. A great proportion of the books which he publifhed were Latin: They are printed in the Roman letter, and are not inelegant, though fome of them abound rather too much in contractions. He died about the year 1520, and left behind him three fons, Francis, Robert, and Charles. His widow married Simeon de Colines (*Colinæus* in Latin), who thus got poffeffion of Henry's printing-houfe, and continued the profeffion till his death.

Of FRANCIS, the eldeft fon, little more is known than that he carried on bufinefs along with his father-in-law Colinæus, and that he died at Paris in 1550.

ROBERT STEPHENS, the fecond fon, was born in 1503. In his youth he made great proficiency in the Roman, Greek, and Hebrew languages, and at the age of 19 had acquired fo much knowledge, that his father-in-law entrufted him with the management of his prefs. An edition of the New Teftament was publifhed under his infpection, which gave great offence to the Paris divines, who accufed him of herefy, and threatened to prevent the fale of the book. Soon after he began bufinefs himfelf, and married Perrete the daughter of Jodocus Badius, a printer and an author. She was a woman of learning, and underftood Latin, which indeed was the neceffary confequence of her fituation. Her hufband always entertained a number of learned men as correctors of the prefs: Being foreigners, and of different nations, they made ufe of no other language but Latin; which Perrete being accuftomed to hear, was able in a fhort time

not

The ALPHABET with Double and Triple Consonants

Let.	Char.	Arb. Abbrev.	D C & Char.		Arb. Abbrev.
a	,	a. an. above	ch	˥	each such
b	c	be. by. because	sh	6	shall. she
c	͝	~~	th	ſ	that they
d	ɔ	do. did	thr	ρ	therefore
e	,	ever every. mid	str	∝	strive. strong
f	ɑ	from if	wh	‿	who which
g j	σ	God give. gives			
h	/	he. had. his			
i	.	I. eye. below			
k	\	king know			
l	/	Lord will all			
m	∩	me. my most			
n	∪	and in nature			
o	.	O oh. owe above			
p	ρ	people. peace			
q	ɑ	question quantity			
r	/	or are			
s	—	is. us. soon			
t	|	the. to. it			
v	σ	have. save			
u	.	you. view. middle			
w	—	we with			
x	ɗ	example. exemple			
y	.	ye your. yes. bel			
z	—	~~ .			

Vowels Places

a. e. i. o. u. y.

Rows: b, d, f, g, h, k, lr, m, n, p, q, s, l, v, w, x

The PREPOSITIONS and TERMINATIONS.

Prepos.	Char.	Ex.	Signifi.	Term.	Char.	Ex.	Signifi.
abs obs	c		abstain	able ible	c		stable
anti ante, anta	.		antidote	flict, flect, full, ference	ɑ		afflict
contr-i-a, contro, counter	\		counterfeit				
dis-incom	ɔ		discompose	ing	∘		thing
				ings	.		things
hyp-o-er	/		hypocrite	tion cion, sion, cian, tian &c	∘		petition
magn-i-a, multi	∩		magnify				
omni	.		omniscience				
int-er-ro, enter	∪		entertain	tions &c, ss ces, nys ous	.		petitions
post, preter	ρ		postpone	tious, cious &c			theses
recon, recom	/		reconcile	less	/		harmless
satis, super, circum	—		satisfy	ment	∩		indictment
				self			
trans	|		transfer	stract, struct	—		substract
ext-er-in, extra	ɗ		extirpate	ward	—		forward

Arbitraries.

: on one	,, as
.. for	; only
∘ of oft often	∘ nothing
o at am	∩ wherefore

Points.

A Comma	,	A Semicolon	;
A Colon	.	A Period	/
A Point of Interrogation	?		
A Point of Admiration	!		

Figures.

1 2 3 4 5 6 7 8 9 0

1779. £567. 17.

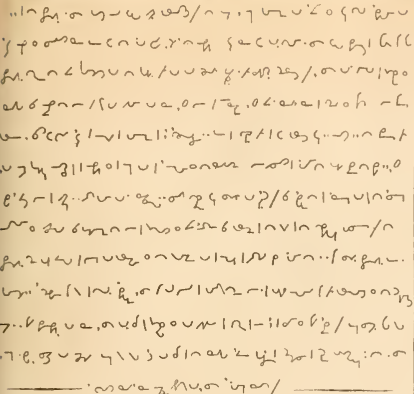
Abbreviating Marks

A Substantive	¡	Division	;
An Adjective	!	Divisible	?
A Verb	¡	Divide	;
A Participle	!	Dividing	?

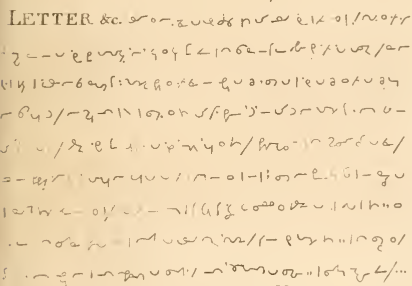
The LORDS Prayer.

W. Prain Sculpt.

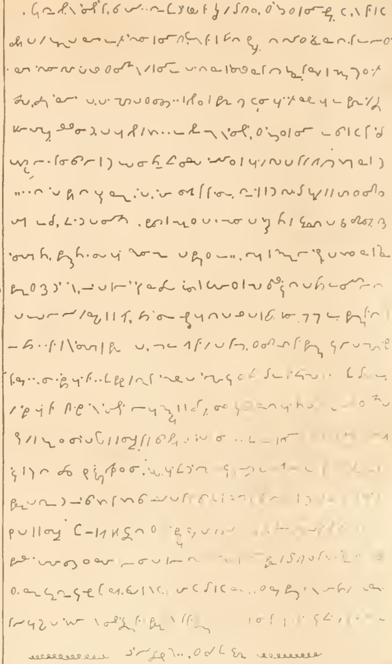
FABRICIUS' Reply to PYRRHUS.



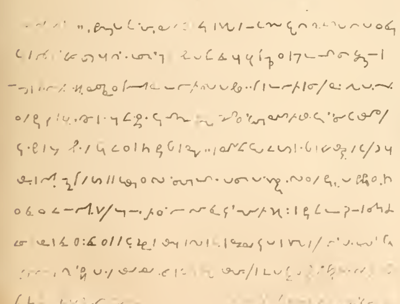
LETTER &c.

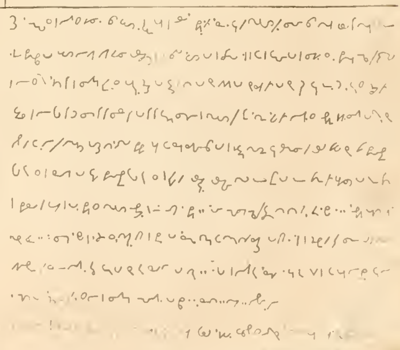


St PAUL'S SPEECH.



POPE to ATTERBURY.





Stephens. not only to underſtand, but even to ſpeak with tolerable eaſe.

In 1531 he publiſhed his Latin "Theſaurus;" a work of great importance, which he laboured at for two years. The mark which he put upon all his books was a tree branched, with a man looking upon it, and theſe words *noli altum ſapere*, to which he ſometimes added *ſed time*. In 1539, Francis I. made him his printer, and ordered a new ſet of elegant types to be founded for him. His frequent editions of the New Teſtament gave great offence to the doctors of the Sorbonne, who accuſed him of hereſy for his annotations, and infiſted upon the ſuppreſſion of ſome of his books. Although Henry the French king in ſome meaſure protected him, the perſecution of theſe divines rendered him ſo unhappy, not to mention the expence and loſs of time which an almoſt conſtant attendance at court unavoidably occaſioned, that in 1552 he abandoned his country and went to Geneva. Here he embraced the Proteſtant religion, and thus juſtified in ſome meaſure the ſuſpicions of his theological enemies. It has been affirmed by ſeveral writers that he carried along with him the royal types, and the moulds alſo in which they were caſt; but it is certain that he never afterwards made uſe of thoſe types. Beſides, is it poſſible that the author of ſo daring a theft could have been not only protected in Geneva, but even courted and honoured by the moſt eminent men of the age? Is it credible that ſuch a crime could have been concealed for 60 years; or that Henry, the ſon and heir of the perpetrator, would have enjoyed the favour of the French king, if Robert Stephens had acted ſuch a ſhameful part? If he was burnt in effigy at Paris, it was not for theft, but for having changed his religion. After his arrival at Geneva, he publiſhed an account of the diſpute between him and the Paris divines, which does as much honour to his abilities as his *Theſaurus* does to his learning. He died in 1559, after a life of the moſt extraordinary induſtry. The books of which he was the editor were not fewer than 360. Many of them were ancient claſſics in different languages. Several were accompanied with annotations which he collected, and all of them were corrected by collating manuſcripts. He was ſo anxious to obtain perfect accuracy, that he uſed to expoſe his proofs in public, and reward thoſe who diſcovered a miſtake. His books conſequently were very correct. It is ſaid that his New Teſtament, called *O Mirificam* (becauſe the preface begins with theſe words), has not a ſingle fault.

It was Robert Stephens who firſt divided the New Teſtament into verſes during a journey between Paris and Lyons. The advantages of this improvement are fully counterbalanced by its defects. It has deſtroyed the unity of the books, and induced many commentators to conſider every verſe as a diſtinct and independent aphoriſm. To this in ſome meaſure is to be aſcribed the many abſurd interpretations and creeds that have been forced out of that book.

By his laſt will his eſtate was left excluſively to ſuch of his children as ſhould ſettle at Geneva. He left behind him three ſons, Henry, Robert, and Francis.

Charles Stephens, the third ſon of Henry, was, like the reſt of his family, familiarly acquainted with the learned languages. This recommended him to Lazarus de Baif, who made him tutor to his ſon, and in 1540 carried him along with him to Germany. He ſtudied medicine, and practiſed it with ſucceſs in France. He did not, however, forſake the profeſſion of his family, but exerciſed it in Paris, where he became the editor of many books remarkable for neatneſs and elegance. He wrote above thirty treatiſes on different ſubjects, particularly on botany, anatomy, and hiſtory. He died in 1564.

Robert Stephens, the ſon of Robert the firſt of that name, did not accompany his father to Geneva, but continued to profeſs the Catholic religion, and to reſide at Paris. His letter was remarkably beautiful.—He was made king's printer, and died about 1589.

His brother Francis was alſo a printer. He embraced the Proteſtant religion, and reſided at Geneva.

Henry Stephens, the remaining ſon of Robert, was born at Paris in 1528. He became the moſt learned and moſt celebrated of all his family. From his very birth almoſt he gave proofs of uncommon abilities, and diſplayed an ardent paſſion for knowledge. The Medea of Euripides, which he ſaw acted while at ſchool, firſt kindled his love for poetry, and inſpired him with the deſire of acquiring the language in which that tragedy is written. He intreated his father not to condemn him to ſtudy Latin, which he already underſtood from converſation, but to initiate him at once into the knowledge of Greek. His father willingly granted his requeſt; and Henry applied with ſuch vigour, that in a ſhort time he could repeat the Medea by heart. He afterwards ſtudied Greek under Peter Daneſius, who was tutor to the Dauphin, and finally heard the lectures of Tuſanus and Turnebus. He became eager at an early age to underſtand aſtrology, and accordingly attended a profeſſor of that myſterious art; but he was not long in diſcovering its abſurdity. At 19 he began his travels, which he undertook in order to examine foreign libraries, and to become acquainted with learned men. He ſpent two years in Italy, and returned into France completely maſter of Italian, and bringing along with him copies of ſeveral ſcarce authors, particularly a part of Anacreon, which before was thought loſt.

He found his father publiſhing an edition of the New Teſtament, to which he prefixed ſome Greek verſes.—Soon after, he viſited England and the Netherlands, where he met with John Clement, an Engliſhman, to whom he was indebted for the remaining odes of Anacreon. During this journey he learned the Spaniſh language, which was very much ſpoken at that time in the Low Countries.

Whether Henry accompanied his father to Geneva or not is uncertain; at leaſt he muſt have returned immediately to France, for we find him ſoon after eſtabliſhed at Paris, and publiſhing the odes of Anacreon. In 1554 he went to Rome, and thence to Naples. This journey was undertaken at the requeſt, and in the ſervice, of the French government. He was diſcovered, and would have been arreſted as a ſpy, had he not by his addreſs and ſkill in the language of the country been able to paſs himſelf for a native of Italy. On his return to France he aſſumed the title of printer to Ulric Fugger, a very rich and learned German nobleman, who allowed him a conſiderable penſion.

In 1560 he married a relation, as is generally ſuppoſed, of Henry Scrimgeour, a Scotch nobleman, with whom he was intimately acquainted. She was a woman, as he himſelf informs us, endowed with the nobleſt ſpirit

Stephens.

spirit and the most amiable dispositions. Her death, which happened in 1586, brought on a disease that had twice attacked him before. It was a disgust at all those pursuits which had formerly charmed him, an aversion to reading and the sight of books. It was probably occasioned by too constant and severe an application to literary pursuits. In 1572 he published his *Thesaurus Linguæ Græcæ*, one of the greatest works, perhaps, that ever was executed by one man, if we consider the wretched materials which more ancient dictionaries could furnish, if we consider the size and perfection of the work, and the immense labour and learning which must have been employed in the compilation. This work had been carried on at a greater expence than he could well bear. He expected to be reimbursed by the sale of the book, but he was unfortunately disappointed. John Scapula, one of his own servants, extracted from it whatever he thought would be most serviceable to students, and published it beforehand in 4th. By this act of treachery Henry was reduced to poverty.

See *Scapula*.

About this time he was much beloved by Henry III. of France, who treated him so kindly, and made him such flattering promises, that he resided frequently at court. But these promises were never fulfilled, owing to the civil wars which soon after distracted France, and the unfortunate death of King Henry himself. During the remainder of his life his situation was very unsettled. We find him sometimes at Paris, sometimes in Geneva, in Germany, and even in Hungary. He died at Lyons in 1598, at the age of 70. He was fond of poetry from his very infancy. It was a custom of his to compose verses on horseback, and even to write them, though he generally rode a very mettlesome steed. His *Thesaurus* was his great work, but he was also the author of several other treatises. His poems are numerous: His Apology for Herodotus is a witty satire on the Roman Catholics. His Concordance to the New Testament must have been a laborious work, and has deservedly endeared him to every Christian who wishes to acquire a rational and critical knowledge of the Scriptures. The number of books which he published, though fewer than his father, was great, and superior in elegance to any thing which the world had then seen. A great proportion of them were Greek; he was the editor, however, of many Roman and even of some eastern writings. His Greek classics are remarkably correct; the principal of them are Homer, Anacreon, Æschylus, Maximus Tyrius, Diodorus Siculus, Pindar, Xenophon, Thucydides, Herodotus, Sophocles, Diogenes Laertius, Plutarch, Plato, Apollonius Rhodius, Æschines, Lysias, Callimachus, Theocritus, Herodian, Dionysius Hallicarnassensis, Dion Cassius, Isocrates, Appian, Xiphilin, &c. His temper in the latter part of his life is represented as haughty and severe, owing probably to his disappointments. He left behind him a son and two daughters, one of whom was married to the learned Isaac Casaubon.

Paul Stephens, the son of Henry, continued his father's profession at Geneva. He was a man of learning, and wrote translations of several books, and published a considerable number of the ancient classics; but his editions possess little of his father's elegance. He died in 1627, at the age of 60, after selling his types to one Chouet a printer.—His son Antony, the last printer of the family, abandoned the Protestant religion, and returned to France, the country of his ancestors. He received letters of naturalization in 1612, and was made printer to the king; but managing his affairs ill, he was reduced to poverty, and obliged to retire into an hospital, where he died in 1674, miserable and blind, at the age of 80.

Stephens ‖ Stereometer.

STERCORARIANS, or Stercoranistæ, formed from *stercus* "dung," a name which those of the Romish church anciently gave to such as held that the host was liable to digestion, and all its consequences, like other food.

STERCULIA, a genus of plants belonging to the class monœcia; and in the natural system ranging under the 38th order, *tricoccæ*. See Botany *Index*.

STEREOGRAPHIC projection, is the projection of the circles of the sphere on the plane of some one great circle, the eye being placed in the pole of that circle. See *Projection of the Sphere*.

STEREOMETER, an instrument invented in France for measuring the volume of a body, however irregular, without plunging it in any liquid. If the volume of air contained in a vessel be measured, when the vessel contains air only, and also when it contains a body whose volume is required to be known, the volume of air ascertained by the first measurement, deducting the volume ascertained by the second, will be the volume of the body itself. Again, if the volume of any mass of air be inversely as the pressure to which it is subjected, the temperature being supposed constant, it will be easy to deduce, from the mathematical relations of quantity, the whole bulk if the difference between the two bulks under two known pressures be obtained by experiment.

Suppose that the first pressure is double the second, or the second volume of air double the first, and the difference equal to 50 cubic inches; the first volume of air will likewise be 50 cubic inches. The design of the stereometer is to ascertain this difference at two known pressures.

The instrument is a kind of funnel AB (fig. 1.) composed of a capsule A, in which the body is placed, and the tube B as uniform in the bore as can be procured. The upper edge of the capsule is ground with emery, that it may be hermetically closed with a glass cover M slightly greased. A double scale is pasted on the tube, having two sets of graduations; one to denote the length, and the other the capacities, as determined by experiment.

Plate DIX. Fig. 1.

When this instrument is used, it must be plunged into a vessel of mercury, with the tube very upright, till the mercury rise within and without to a point C of the scale. See fig. 2.

Fig. 2.

The capsule is then closed with the cover, which being greased will prevent its communication between the external air and that contained within the capsule and tube.

In this situation of the instrument, the internal air is compressed by the weight of the atmosphere, expressed by the length of the mercury in the tube of the common barometer.

The instrument is then elevated, still keeping the tube in the vertical position. It is thus represented, fig. 2. second position. The mercury descends in the tube, but not to the level of the external surface, and a column of mercury DE remains suspended in the tube, the height of which is known by the scale. The interior air is less compressed

Fig. 1.

Fig. 2.

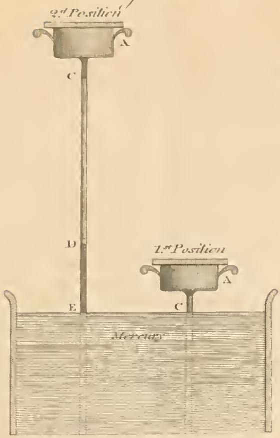
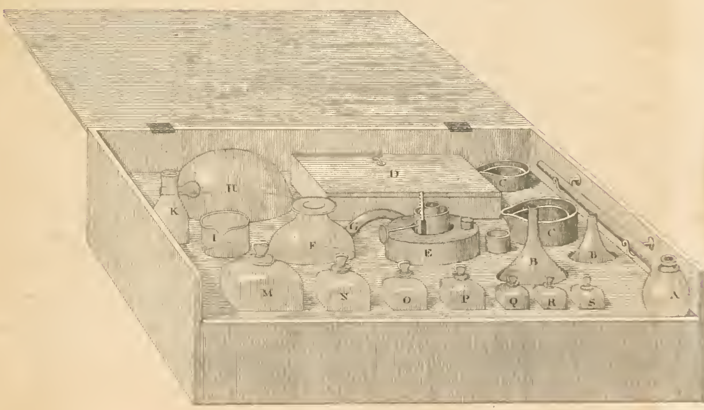


Fig. 3.

SOILS Analysis of.



W. Train Sculpt.

compreffed than before, the increafe of its volume being equal to the whole capacity of the tube from C to D, indicated by the fecond fcale.

It is therefore known that the preffures are in proportion to the barometrical column, and to the fame column —DE. The bulks of the air in thefe two ftates are inverfely in the fame proportion; and the difference between thefe bulks is the abfolute quantity left void in the tube by the fall of the mercury; from which data the following rule is deduced. Multiply the number expreffing the lefs preffure by that which denotes the augmentation of capacity, and divide the product by the number which denotes the difference of the preffures. The quotient is the bulk of the air when fubject to the greater preffure.

Suppofe the height of the mercury in the barometer to be 78 centimetres, and the inftrument being empty to be plunged into the mercury to the point C. It is then covered and raifed till the fmall column of mercury DE is fufpended, fay at the height of fix centimetres. The internal air at firft compreffed by a force reprefented by 78 centimetres, is now only compreffed by a force $= 72$ centimetres, or $78 - 6 = 72$.

Suppofe that the capacity of the part CD of the tube which the mercury has quitted is two cubic centimetres.

Then $\frac{72}{6} \times 2 = 24$ cubical centimetres, the volume of the air included in the inftrument when the mercury rofe as high as C in the tube.

The body of which the volume is to be afcertained muft then be placed in the capfule, and the operation repeated. Let the column of mercury fufpended be $=8$ centimetres, when the capacity of the part CD of the tube is $=2$ centimetres cubic. Then the greateft preffure being denoted by 78 centimetres, the leaft will be 70 centimetres, the difference of preffure being 8, and difference of the volumes two cubic centimetres.

Hence $\frac{70}{8} \times 2$ gives the bulk of the included air under the greateft preffure 17.5 cubic centimetres. Then $24 - 17.5 = 6.5$ the volume of the body introduced. If the abfolute weight of the body be multiplied by its bulk in centimetres, and divided by the abfolute weight of one cubic centimetre of diftilled water, the quotient will be $=$ the fpecific gravity of the body in the common form of the tables, where diftilled water is taken as unity, or the term of comparifon.

Mr Nicholfon fuppofes that the author of the invention had not finifhed his meditations on the fubject. If he had, it is probable that he would have determined his preffures, as well as the meafures of bulks, by weight. For if the whole inftrument were fet to its pofitions by
Fig. 3. fufpending it from one arm of a balance at H (fig. 3.) the quantity of counterpoife, when in equilibrio, might be applied to determine the preffures to a degree of accuracy much greater than can be obtained by linear meafurement.

STEREOMETRY, Στερεομετρια, formed of στερεος *folid*, and μετρον *meafure*, that part of geometry which teaches how to meafure folid bodies, i. e. to find the folidity or folid contents of bodies; as globes, cylinders, cubes, veffels, fhips, &c.

STEREOTOMY, formed from στερεος, and τομη, *fection*, the art or act of cutting folids, or making fections thereof; as walls and other membranes in the profiles of architecture.

STEREOTYPE PRINTING, a method of printing, which was introduced into this country by William Ged of Edinburgh before the middle of the 18th century, and which has been revived of late, and greatly improved by the French. It has alfo been brought into practice in Britain by Earl Stanhope, who has produced fome beautiful fpecimens of it. Some perfons feem difpofed to difpute the invention of Ged, feeing that the fame method of printing by wooden blocks was practifed by the Chinefe and Japanefe many hundred years ago. See GED, *life of*, and PRINTING.

STERILITY, barrennefs, in oppofition to fertility. It has been afferted by many authors, that all monfters produced by a mixture of different fpecies of animals, fuch as mules, are barren; but this does not hold univerfally, even with the mule, which is the inftance moft generally adduced.

Sterility in women fometimes happens from a mifcarriage, or violent labour injuring fome of the genital parts; but one of the moft frequent caufes is the fuppreffion of the menftrual flux.—There are other caufes arifing from various difeafes incident to thofe parts, by which the uterus may be unfit to receive or retain the male feed;—from the tubæ fallopianæ being too fhort, or having loft their erective power; in either of which cafes no conception can take place;—from univerfal debility and relaxation; or a local debility of the genital fyftem; by which means, the parts having loft their tone or contractile power, the femen is thrown off immediately *poft coitum*;—from imperforation of the vagina, the uterus, or the *tubæ*, or from difeafed ova, &c. Hence medical treatment can only avail in cafes arifing from topical or univerfal debility; in correcting irregularities of the menftrual flux, or in removing tumors, cicatrices, or conftrictions of the paffage, by the art of furgery.

STERIS, a genus of plants belonging to the clafs pentandria. See BOTANY *Index*.

STERLING, an epithet by which genuine Englifh money is diftinguifhed. It is unneceffary to mention the various conjecturies of antiquaries about the origin and meaning of this appellation. The moft probable opinion feems to be this, that fome artifts from Germany, who were called *Efterlings*, from the fituation of their country, had been employed in fabricating our money, which confifted chiefly of filver pennies; and that from them the penny was called an *efterling*, and our money *efterling* or *fterling* money. *Henry's Hiftory of Great Britain*, vol. ii. p. 541.

STERN, the pofterior face of a fhip; or that part which is reprefented to the view of a fpectator, placed on the continuation of the keel behind. The ftern is terminated above by the taffarel, and below by the counters; it is limited on the fides by the quarter-pieces, and the intermediate fpace comprehends the galleries and windows of the different cabins. See QUARTER *of a Ship*, SHIP, and SHIP-BUILDING.

STERN-Faft, a rope ufed to confine the ftern of a fhip or boat to any wharf or jetty head, &c.

STERN-Moft, in fea language, ufually denotes that part of a fleet of fhips which is in the rear, or fartheft a-ftern, as oppofed to head-moft.

STERN-Poſt, a long ſtraight piece of timber erected on the extremity of the keel, to ſuſtain the rudder and terminate the ſhip behind.

This piece ought to be well ſecured and ſupported; becauſe the ends of all the lower planks of the ſhip's bottom are fixed in a channel, cut on its ſurface; and the whole weight of the rudder is ſuſtained by it.

STERN-Sheets, that part of a boat which is contained between the ſtern and the aſtmoſt or hindmoſt ſeat of the rowers. It is generally furniſhed with benches to accommodate the paſſengers. See BOAT.

STERNA, the TERN; a genus of birds arranged under the order of *palmipedes*. See ORNITHOLOGY *Index*.

STERNE, LAURENCE, an Engliſh writer of a very peculiar caſt, was born at Clomwell, in the ſouth of Ireland, on 24th November 1713. His father Roger Sterne was the grandſon of Sterne archbiſhop of York, who has been ſuppoſed, we know not upon what grounds, to have been the author of the excellent book entitled "The Whole Duty of Man." Laurence inherited nothing of his anceſtor's manner of writing, but rather reſembled Rabelais, whoſe wit he carried with him even into the pulpit.

In 1722 he was ſent to ſchool at Halifax in Yorkſhire, where he continued till 1732, when he was removed to Jeſus College in Cambridge. How long he reſided in college, or what progreſs he made in literature or ſcience, is not known: his works diſplay rather native genius than profound erudition. Upon quitting the univerſity he went to York, and being in orders was preſented to the living of Sutton by the intereſt of his uncle Dr Sterne, a prebendary of that church. In 1741 he married, and was ſoon afterwards made a prebendary of York, by the intereſt alſo of his uncle, who was then upon very good terms with him; but "quickly quarrelled with him (he ſays), and became his bittereſt enemy, becauſe he would not be a party man, and write paragraphs in the newſpapers." By his wife's means he got the living of Stillington, but remained near 20 years at Sutton, doing duty at both places. He was then in very good health, which, however, ſoon after forſook him; and books, painting, fiddling, and ſhooting, were, as he tells us, his amuſements.

In 1760, he went to London to publiſh his two firſt volumes of "Triſtram Shandy;" and was that year preſented to the curacy of Coxwold. In 1762 he went to France, and two years after to Italy, for the recovery of his health; but his health never was recovered. He languiſhed under a conſumption of the lungs, without the ſlighteſt depreſſion of ſpirits, till 1768, when death put a period to his terreſtrial exiſtence.

The works of Sterne are very generally read. They conſiſt of, 1. The Life and Opinions of Triſtram Shandy; 2. Sermons; 3. A Sentimental Journey; 4. Letters, publiſhed ſince his death. In every ſerious page, and in many of much levity, the author writes in praiſe of benevolence, and declares that no one who knew him could ſuppoſe him one of thoſe wretches who heap miſfortune upon misfortune: But we have heard anecdotes of him extremely well authenticated, which proved that it was eaſier for him to praiſe this virtue than to practiſe it. His wit is univerſally allowed; but many readers have perſuaded themſelves that they found wit in his blank pages, while it is probable that he intended nothing but to amuſe himſelf with the idea of the ſage conjectures to which theſe pages would give occaſion. Even his originality is not ſuch as is generally ſuppoſed by thoſe fond admirers of the Shandean manner, who have preſumed to compare him with Swift, Arbuthnot, and Butler. He has borrowed both matter and manner from various authors, and in particular from an old work, "The Anatomy of Melancholy by Burton," as every reader may be convinced by the learned, elegant, and candid comments on his works publiſhed by Dr Ferriar, in the fourth volume of the Memoirs of the Literary and Philoſophical Society of Mancheſter.

STERNOCOSTALES, commonly called the *muſculi triangulares ſterni*, in *Anatomy*, are five pairs of fleſhy planes, diſpoſed more or leſs obliquely on each ſide the ſternum, on the inſides of the cartilages of the ſecond, third, fourth, fifth, and ſixth true ribs.

STERNO-HYOIDÆUS, in *Anatomy*. See *Table of the Muſcles*, under the article ANATOMY.

STERNOMANTIS, in antiquity, a deſignation given to the Delphian prieſteſs, more uſually called PYTHIA.—Sternomantis is alſo uſed for any one that had a propheſying demon within him.

STERNOMASTOIDÆUS, a muſcle. See *Table of the Muſcles*, under ANATOMY.

STERNOTHYROIDEUS, a muſcle. See *Table of the Muſcles*, under ANATOMY.

STERNUM. See ANATOMY *Index*.

STERNUTATIVE, or STERNUTATORY, a medicine proper to produce ſneezing. See SNEEZING.

STETIN, or STETTIN, a ſea-port town of Germany, in the circle of Upper Saxony, and capital of Hither Pomerania, with the title of a duchy, and a caſtle. It had long a famous ſchool, which the wars of Germany never diſturbed. The ancient dukes of Pomerania reſided here; and it was taken by the elector of Brandenburg in 1676, but given to Sweden by the treaty of Nimeguen. In 1713 it ſubmitted to the allies; and then the ſaid elector was put in poſſeſſion again of this important place, which is a bulwark to the marche of Brandenburg; and the fortifications have been greatly improved. It is now a flouriſhing place, and carries on a conſiderable trade. It is ſeated on the river Oder, 72 miles north of Francfort, and 70 north by eaſt of Berlin. E. Long. 14. 38. N. Lat. 53. 35. The duchy is 125 miles in length, and borders upon Mecklenburg, and partly upon Brandenburg. The breadth is from 17 to 25 miles, and it is divided by the river Oder into two parts.

STEW, a ſmall kind of fiſh-pond, the peculiar uſe of which is to maintain fiſh, and keep them in readineſs for the daily uſe of the family, &c.

STEWS (from the French *eſtuves*, i. e. *thermæ*, *balneum*), thoſe places which were permitted in England to women of profeſſed incontinency; ſo called, becauſe diſſolute perſons are wont to prepare themſelves for venereous acts by bathing; and hot baths were by Homer reckoned among the effeminate ſort of pleaſures. Theſe ſtews were ſuppreſſed by King Henry VIII. about the year 1546.

STEWARD (*ſeneſcallus*, compounded of the Saxon *ſteda*, i. e. "room" or "ſtead," and *weard*, "a ward" or "keeper"), an officer appointed in another's ſtead or place, and always taken for a principal officer within his juriſdiction.

Steward. jurifdiction. Of thefe there are various kinds. The greateft officer under the crown is the lord high-fteward of England, an office that was anciently the inheritance of the earls of Leicefter, till forfeited by Simon de Mountfort to King Henry III. But the power of this officer is fo very great, that it has not been judged fafe to truft it any longer in the hands of a fubject, excepting only *pro hac vice*, occafionally: as to officiate at a coronation, at the arraignment of a nobleman for high-treafon, or the like. During his office, the fteward bears a white ftaff in his hand; and the trial, &c. ended, he breaks the ftaff, and with it his commiffion expires. There is likewife a lord-fteward of the king's houfehold, who is the chief officer of the king's court, has the care of the king's houfe, and authority over all the officers and fervants of the houfehold, except fuch as belong to the chapel, chamber, and ftable.

Steward, an officer in a fhip of war, appointed by the purfer to diftribute the different fpecies of provifions to the officers and crew; for which purpofe he is furnifhed with a mate and proper affiftants.

Court of the Lord High Steward of Great Britain, is a court inftituted for the trial of peers indicted for treafon or felony, or for mifprifion of either. The office of this great magiftrate is very ancient, and was formerly hereditary, or at leaft held for life, or *dum bene fe gefferit:* but now it is ufually, and hath been for many centuries paft, granted *pro hac vice* only; and it hath been the conftant practice (and therefore feems now to have become neceffary) to grant it to a lord of parliament, elfe he is incapable to dry fuch delinquent peer. When fuch an indictment is therefore found by a grand jury of freeholders in the King's bench, or at the affizes before the juftices of *oyer* and *terminer*, it is to be removed by a writ of *certiorari* into the court of the lord high-fteward, which has the only power to determine it. A peer may plead a pardon before the court of King's-bench, and the judges have power to allow it, in order to prevent the trouble of appointing an high-fteward merely for the purpofe of receiving fuch plea: but he may not plead in that inferior court any other plea, as guilty or not guilty of the indictment, but only in this court; becaufe, in confequence of fuch plea, it is poffible that judgement of death might be awarded againft him. The king, therefore, in cafe a peer be indicted of treafon, felony, or mifprifion, creates a lord high-fteward *pro hac vice* by commiffion under the great feal; which recites the indictment fo found, and gives his Grace power to receive and try it *fecundum legem et confuetudinem Angliæ*. Then when the indictment is regularly removed by writ of *certiorari*, commanding the inferior court to certify it up to him, the lord high-fteward directs a precept to a ferjeant at arms, to fummon the lords to attend and try the indicted peer. This precept was formerly iffued to fummon only 18 or 20 felected from the body of the peers; then the number came to be indefinite; and the cuftom was for the lord-high-fteward to fummon as many as he thought proper (but of late years not lefs than 23); and that thofe lords only fhould fit upon the trial; which threw a monftrous weight of power into the hands of the crown, and this its great officer, of felecting only fuch peers as the then predominant party fhould moft approve of. And accordingly, when the earl of Clarendon fell into difgrace with Charles II. there was a defign formed to prorogue the parliament, in order to try him by a felect number of peers; it being doubted whether the whole houfe could be induced to fall in with the views of the court. But now, by ftatute 7 W. III. c. 3. upon all trials of peers for treafon or mifprifion, all the peers who have a right to fit and vote in parliament fhall be fummoned at leaft 20 days before fuch trial, to appear and vote therein; and every lord appearing fhall vote in the trial of fuch peer, firft taking the oaths of allegiance and fupremacy, and fubfcribing the declaration againft popery.

Blackft. Comment. vol. iv.

During the feffion of parliament, the trial of an indicted peer is not properly in the court of the lord high-fteward, but before the court laft mentioned of our lord the king in parliament. It is true, a lord high-fteward is always appointed in that cafe to regulate and add weight to the proceedings: but he is rather in the nature of a fpeaker *pro tempore*, or chairman of the court, than the judge of it; for the collective body of the peers are therein the judges both of law and fact, and the high-fteward has a vote with the reft in right of his peerage. But in the court of the lord high-fteward, which is held in the recefs of parliament, he is the fole judge of matters of law, as the lords triors are in matters of fact; and as they may not interfere with him in regulating the proceedings of the court, fo he has no right to intermix with them in giving any vote upon the trial. Therefore, upon the conviction and attainder of a peer for murder in full parliament, it hath been holden by the judges, that in cafe the day appointed in the judgement for execution fhould lapfe before execution done, a new time of execution may be appointed by either the high court of parliament during its fitting, though no high-fteward be exifting, or, in the recefs of parliament, by the court of King's-bench, the record being removed into that court.

It has been a point of fome controverfy, whether the bifhops have now a right to fit in the court of the lord-high-fteward to try indictments of treafon and mifprifion. Some incline to imagine them included under the general words of the ftatute of King William "all peers who have a right to fit and vote in parliament;" but the expreffion had been much clearer, if it had been "all lords," and not "all peers;" for though bifhops, on account of the baronies annexed to their bifhoprics, are clearly lords of parliament, yet their blood not being ennobled, they are not univerfally allowed to be peers with the temporal nobility: and perhaps this word might be inferted purpofely with a view to exclude them. However, there is no inftance of their fitting on trials for capital offences, even upon impeachments or indictments in full parliament, much lefs in the court we are now treating of; for indeed they ufually withdraw voluntarily, but enter a proteft, declaring their right to ftay. It is obfervable, that in the 11th chapter of the conftitutions of Clarendon, made in parliament 11th Henry II. they are exprefsly excufed, rather than excluded, from fitting and voting in trials, which concern life or limb: *epifcopi, ficut cæteri barones, debent intereffe judiciis cum baronibus, quoufque perveniatur ad diminutionem membrorum vel ad mortem.* And Becket's quarrel with the king hereupon was not on account of the exception (which was agreeable to the canon law), but of the general rule, that compelled the bifhops to attend at all. And the determination of the houfe of lords

lords in the earl of Danby's cafe, which hath ever fince been adhered to, is confonant to thefe conftitutions; "that the lords fpiritual have a right to ftay and fit in court in capital cafes, till the court proceeds to the vote of guilty or not guilty." It muft be noted, that this refolution extends only to trials in full parliament; for to the court of the lord high-fteward (in which no vote can be given, but merely that of guilty or not guilty), no bifhop, as fuch, ever was or could be fummoned: and though the ftatute of King William regulates the proceedings in that court, as well as in the court of parliament, yet it never intended to new-model or alter its conftitution; and confequently does not give the lords fpiritual any right, in cafes of blood, which they had not before. And what makes their exclufion more reafonable is, that they have no right to be tried themfelves in the court of the lord high-fteward, and therefore furely ought not to be judges there. For the privilege of being thus tried depends upon nobility of blood rather than a feat in the houfe, as appears from the trials of the popifh lords, of lords under age, and (fince the union) of the Scotch nobility, though not in the number of the fixteen; and from the trials of females, fuch as the queen confort or dowager, and of all peereffes by birth; and peereffes by marriage alfo, unlefs they have, when dowagers, difparaged themfelves by taking a commoner to their fecond hufband.

STEWARD of the Chiltern Hundreds. See *CHILTERN Hundreds.*

STEWART, DR MATTHEW, an eminent mathematician, was in 1717 born at Rothfay in the ifle of Bute, of which parifh his father was minifter. Being intended for the church, he went through the ufual courfe of a grammar-fchool education, and was in 1734 received as a ftudent into the univerfity of Glafgow. There he had the happinefs of having for his preceptors in moral fcience and in mathematics the celebrated profeffors Hutchefon and Simfon; by the latter of whom he was inftructed in what may not improperly be called the *arcana* of the ancient geometry.

Account of Dr Stewart in the Edinburgh Philofophical Tranfactions, vol. i. by Mr Playfair.

Mr Stewart's views making it neceffary for him to remove to Edinburgh, he was introduced by Dr Simfon to Mr Maclaurin, that his mathematical ftudies might fuffer no interruption; and he attended the lectures of that great mafter with fuch advantage as might be expected from eminent abilities, directed by the judgement of him who made the philofophy and geometry of Newton intelligible to ordinary capacities. Mr Stewart, however, had acquired, from his intimacy with Dr Simfon, fuch a predilection for the ancient geometry, as the modern analyfis, however powerfully recommended, could not leffen; and he kept up a regular correfpondence with his old mafter, giving him an account of his progrefs and his difcoveries in geometry, and receiving in return many curious communications refpecting the *Loci Plani* and the porifms of Euclid. See PORISM and SIMSON.

While the fecond invention of porifms, to which more genius was perhaps required than to the firft difcovery of them, employed Dr Simfon, Mr Stewart purfued the fame fubject in a different and new direction. In doing fo, he was led to the difcovery of thofe curious and interefting propofitions which were publifhed under the title of *General Theorems* in 1746. They were given without the demonftrations; but did not fail to place their difcoverer at once among the geometers of the firft rank. They are for the moft part porifms, though Mr Stewart, careful not to anticipate the difcoveries of his friend, gave them no other name than that of theorems.

Our author had before this period entered into the church; and obtained, through the patronage of the duke of Argyle and the earl of Bute, the living of Rofeneath, a retired country parifh in the weft of Scotland: but in 1747 he was elected to the mathematical chair in the univerfity of Edinburgh, which had become vacant the year before by the death of Mr Maclaurin. The duties of this office gave a turn fomewhat different to his purfuits, and led him to think of the moft fimple and elegant means of explaining thofe difficult propofitions which were hitherto only acceffible to men deeply verfed in the modern analyfis. In doing this, he was purfuing the object which of all others he moft ardently wifhed to attain, viz. the application of geometry to fuch problems as the algebraic calculus alone had been thought able to refolve. His folution of Kepler's problem was the firft fpecimen of this kind which he gave to the world; and it was impoffible to have produced one more to the credit of the method he followed, or of the abilities with which he applied it. On this problem the utmoft refources of the integral calculus had been employed. But though many excellent folutions had been given, there was none of them at once direct in its method and fimple in its principles. Mr Stewart was fo happy as to attain both thefe objects; and his folution appeared in the fecond volume of the Effays of the Philofophical Society of Edinburgh for the year 1756. In the firft volume of the fame collection there are fome other propofitions of Mr Stewart's, which are an extenfion of a curious theorem in the fourth book of Pappus. They have a relation to the fubject of porifms, and one of them forms the 91ft of Dr Simfon's Reftoration. They are befides very beautiful propofitions, and are demonftrated with all the elegance and fimplicity of the ancient analyfis.

The profecution of the plan which he had formed of introducing into the higher parts of mixed mathematics the ftrict and fimple form of ancient demonftration, produced the Tracts Phyfical and Mathematical, which were publifhed in 1761, and the Effay on the Sun's Diftance, which was publifhed in 1763. In this laft work it is acknowledged that he employed geometry on a tafk which geometry cannot perform; but while it is granted that his determination of the fun's diftance is by no means free from error, it may fafely be afferted that it contains a great deal which will always intereft geometers, and will always be admired by them. Few errors in fcience are redeemed by the difplay of fo much ingenuity, and what is more fingular, of fo much found reafoning. The inveftigation is everywhere elegant, and will probably be long regarded as a fpecimen of the moft arduous inquiry which has been attempted by mere geometry.

The Sun's Diftance was the laft work which Dr Stewart publifhed; and though he lived to fee feveral animadverfions on it made public, he declined entering into any controverfy. His difpofition was far from polemical; and he knew the value of that quiet which a literary man fhould rarely fuffer his antagonifts to interrupt. He ufed to fay, that the decifion of the point in in queſtion was now before the public; that if his inveſtigation was right it would never be overturned, and that if it was wrong it ought not to be defended. A few months before he publiſhed the eſſay juſt mentioned, he gave to the world another work, intitled *Propoſitiones Geometricæ More Veterum Demonſtratæ*. This title, it is ſaid, was given to it by Dr Simſon, who rejoiced in the publication of a work ſo well calculated to promote the ſtudy of the ancient geometry. It conſiſts of a ſeries of geometrical theorems for the moſt part new; inveſtigated firſt by an analyſis, and afterwards ſynthetically demonſtrated by the inverſion of the ſame analyſis.

Dr Stewart's conſtant uſe of the geometrical analyſis had put him in poſſeſſion of many valuable propoſitions which did not enter into the plan of any of the works that have been enumerated. Of theſe not a few have found a place in the writings of Dr Simſon, where they will for ever remain to mark the friendſhip of theſe two mathematicians, and to evince the eſteem which Dr Simſon entertained for the abilities of his pupil.

Soon after the publication of the Sun's Diſtance, Dr Stewart's health began to decline, and the duties of his office became burdenſome to him. In the year 1772 he retired to the country, where he afterwards ſpent the greater part of his life, and never reſumed his labours in the univerſity. But though mathematics had now ceaſed to be his buſineſs, they continued to be his amuſement till a very few years before his death, which happened on the 23d of January 1785, at the age of 68.

The habits of ſtudy, in a man of original genius, are objects of curioſity, and deſerve to be remembered. Concerning thoſe of Dr Stewart, his writings have made it unneceſſary to remark, that from his youth he had been accuſtomed to the moſt intenſe and continued application. In conſequence of this application, added to the natural vigour of his mind, he retained the memory of his diſcoveries in a manner that will hardly be believed. He rarely wrote down any of his inveſtigations till it became neceſſary to do ſo for the purpoſe of publication. When he diſcovered any propoſition, he would put down the enunciation with great accuracy, and on the ſame piece of paper would conſtruct very neatly the figure to which it referred. To theſe he truſted for recalling to his mind at any future period the demonſtration or the analyſis, however complicated it might be. Experience had taught him, that he might place this confidence in himſelf without any danger of diſappointment; and for this ſingular power he was probably more indebted to the activity of his invention than the mere tenacioufneſs of his memory. Though he was extremely ſtudious, he read few books, and verified the obſervation of M. D'Alembert, that of all the men of letters, mathematicians read leaſt of the writings of one another. His own inveſtigations occupied him ſufficiently; and indeed the world would have had reaſon to regret the miſapplication of his talents, had he employed in the mere acquiſition of knowledge that time which he could dedicate to works of invention.

STEWART, in *Scots Law*. See LAW *Index*.

STEWARTIA, a genus of plants belonging to the claſs monadelphia, and in the natural ſyſtem ranging under the 37th order, *Columniferæ*. See BOTANY *Index*.

STIBADIUM, among the Romans, a low kind of table couch or bed of a circular form, which ſucceeded to the triclinia, and was of different ſizes, according to the number of gueſts for which it was deſigned. Tables of this kind were called *hexaclina*, *octaclina*, or *enneaclina*, according as they held ſix, eight, or nine gueſts, and ſo of any other number.

STIBIUM, a name for ANTIMONY.

STICHOS, a name given by the old writers to a pectoral confection, the principal ingredient of which was the herb *marrubium* or horehound.

STICKLEBACK, a genus of fiſhes. See GASTEROSTEUS, ICHTHYOLOGY *Index*.

FOOT-STICKS, in *Printing*, ſlips of wood that lie between the foot of the page and the cheſs, to which they are wedged faſt by the quoins, to keep the form firm, in conjunction with the ſide-ſticks, which are placed at the ſide of the page, and fixed in the ſame manner by means of quoins.

STIFFLE, or GREAT MUSCLE, in the manege, is the part of the hind leg of a horſe which advances towards his belly. This is a moſt dangerous part to receive a blow upon.

STIGMA, a brand or impreſſion with a hot iron; a mark of infamy. See STIGMATIZING.

STIGMA, in *Botany*, the ſummit or top of the ſtyle, accounted by the ſexualiſts the female organ of generation in plants, which receives the fecundating duſt of the tops of the ſtamina, and tranſmits its vapour or effluvia through the ſtyle into the heart of the ſeed-bud, for the purpoſe of impregnating the ſeeds.

STIGMATA, in *Natural Hiſtory*, the apertures in different parts of the bodies of inſects communicating with the tracheæ or air-veſſels, and ſerving for the office of reſpiration.

STIGMATA, in antiquity, certain marks impreſſed on the left ſhoulders of the ſoldiers when liſted.

STIGMATA, were alſo a kind of notes or abbreviations, conſiſting only of points, diſpoſed various ways; as in triangles, ſquares, croſſes, &c.

STIGMATA, is alſo a term introduced by the Franciſcans, to expreſs the marks or prints of our Saviour's wounds, ſaid to have been miraculouſly impreſſed by him on the body of their ſeraphic father St Francis.

STIGMATIZING, among the ancients, was inflicted upon ſlaves as a puniſhment, but more frequently as a mark to know them by: in which caſe, it was done by applying a red-hot iron marked with certain letters to their foreheads, till a fair impreſſion was made; and then pouring ink into their furrows, that the inſcription might be the more conſpicuous.

Soldiers were branded in the hand with the name or character of their general.

After the ſame manner, it was cuſtomary to ſtigmatize the worſhippers and votaries of ſome of the gods. The marks uſed on theſe occaſions were various; ſometimes they contained the name of the god, ſometimes his particular enſign, as the thunderbolt of Jupiter, the trident of Neptune, the ivy of Bacchus, &c. or they marked themſelves with ſome myſtical number, whereby the god's name was deſcribed. To theſe three ways of ſtigmatizing St John is ſuppoſed to refer (Rev. chap. xiii. ver. 16, 17.). Theodoret is of opinion, that the

Jews were forbidden to brand themſelves with ſtigmata, becauſe the idolaters, by that ceremony, uſed to conſecrate themſelves to their falſe gods.

Among ſome nations, ſtigmatizing was conſidered as a diſtinguiſhing mark of honour and nobility. In Thrace, as Herodotus tells us *, it was practiſed by none but perſons of credit, nor omitted by any but perſons of the meaneſt rank. The ancient Britons are alſo ſaid to have imprinted on the bodies of their infants the figures of animals, and other marks, with hot irons.

* Lib. v.

STIL DE GRAIN, in the colour trade, the name of a compoſition uſed for painting in oil or water, and is made of a decoction of the lycium or Avignon berry, in alum-water, which is mixed with whiting into a paſte, and formed into twiſted ſticks. It ought to be choſen of a fine gold yellow, very fine, tender, and friable, and free from dirt.

STILAGO, a genus of plants belonging to claſs gynandria. See BOTANY *Index*.

STILBE, a genus of plants belonging to the claſs polygamia, and order of diœcia. See BOTANY *Index*.

STILBITE, a ſpecies of mineral, or variety of zeolite. See ZEOLITE, MINERALOGY *Index*.

STILE. See STYLE.

STILL, the name of an apparatus uſed in chemiſtry for various purpoſes, and in the diſtillation of ardent ſpirits.

STILL-Bottoms, in the diſtillery, a name given by the traders to what remains in the ſtill after working the waſh into low wines. Theſe bottoms are procured in the greateſt quantity from the malt-waſh, and are of ſo much value to the diſtiller in the fattening of hogs, &c. that he often finds them one of the moſt valuable articles of the buſineſs.

STILLINGFLEET, EDWARD, biſhop of Worceſter, was the ſon of Samuel Stillingfleet, gentleman, and was born at Cranborn in Dorſetſhire in 1635. He was educated at St John's College, Cambridge; and having received holy orders, was, in 1657, preſented to the rectory of Sutton in Nottinghamſhire. By publiſhing his *Origines Sacræ*, one of the ableſt defences of revealed religion that has ever been written, he ſoon acquired ſuch reputation, that was appointed preacher of the Rolls Chapel; and in January 1665 was preſented to the rectory of St Andrew's, Holborn. He was afterwards choſen lecturer at the Temple, and appointed chaplain in ordinary to King Charles II. In 1668 he took the degree of doctor of divinity; and was ſoon after engaged in a diſpute with thoſe of the Romiſh religion, by publiſhing his diſcourſe concerning the idolatry and fanaticiſm of the church of Rome, which he afterwards defended againſt ſeveral antagoniſts. In 1680 be preached at Guildhall chapel a ſermon on Phil. iii. 26. which he publiſhed under the title of *The Miſchief of Separation;* and this being immediately attacked by ſeveral writers, he in 1683 publiſhed his Unreaſonableneſs of Separation. In 1685 appeared his *Origines Britannicæ*, or the Antiquities of the Britiſh Church, in folio. During the reign of King James II. he wrote ſeveral tracts againſt popery, and was prolocutor of the convocation, as he had likewiſe been under Charles II. After the Revolution he was advanced to the biſhopric of Worceſter, and was engaged in a diſpute with the Socinians, and alſo with Mr Locke; in which laſt conteſt he is generally thought to have been unſucceſsful. He died at Weſtminſter in 1699, and was interred in the cathedral of Worceſter, where a monument was erected to his memory by his ſon. Dr Stillingfleet wrote other works beſides thoſe here mentioned, which, with the above, have been reprinted in 6 vols. folio.

STILLINGFLEET, *Benjamin*, an ingenious naturaliſt, was grandſon of the preceding. His father Edward was fellow of St John's College in Cambridge, F. R. S. M. D. and Greſham profeſſor of phyſic; but marrying in 1692, he loſt his lucrative offices and his father's favour; a misfortune that affected both himſelf and his poſterity. However, going into orders, he obtained, by his father's means, the living of Newington-Butts, which he immediately exchanged for thoſe of Wood-Norton and Swanton in Norfolk. He died in 1708.

Benjamin, his only ſon, was educated at Norwich ſchool, which he left in 1720, with the character of an excellent ſcholar. He then went to Trinity-College in Cambridge, at the requeſt of Dr Bentley, the maſter, who had been private tutor to his father, domeſtic chaplain to his grandfather, and much indebted to the family. Here he was a candidate for a fellowſhip, but was rejected by the maſter's influence. This was a ſevere and unexpected diſappointment, and but little alleviated afterwards by the Doctor's apology, that it was a pity that a gentleman of Mr Stillingfleet's parts ſhould be buried within the walls of a college.

Perhaps, however, this ingratitude of Dr Bentley was not of any real diſſervice to Mr Stillingfleet. By being thrown into the world, he formed many honourable and valuable connections. He dedicated ſome tranſlations of Linnæus to the late Lord Lyttleton, partly, he ſays, from motives of private reſpect and honour. Lord Barrington gave him, in a very polite manner, the place of the maſter of the barracks at Kenſington; a favour to which Mr Stillingfleet, in the dedication of his Calendar of Flora to that nobleman, alludes with equal politeneſs, as well as with the warmeſt gratitude. His Calendar of Flora was formed at Stratton in Norfolk in the year 1755, at the hoſpitable ſeat of his very worthy and ingenious friend Mr Marſham, who had made ſeveral obſervations of that kind, and had communicated to the public his curious obſervations on the growth of trees. But it was to Mr Wyndham of Felbrig in Norfolk that he appears to have had the greateſt obligations: he travelled abroad with him, ſpent much of his time at his houſe, and was appointed one of his executors (Mr Garrick was another), with a conſiderable addition to an annuity which that gentleman had ſettled upon him in his lifetime.

Mr Stillingfleet's genius ſeems, if we may judge from his works, to have led him principally to the ſtudy of natural hiſtory; which he proſecuted as an ingenious philoſopher, an uſeful citizen, and a good man. In this walk of learning he mentions, as his friends, Dr Watſon, Mr (afterwards Dr) Solander, Mr Hudſon, Mr Price of Foxley, and ſome others; to whom may be added the ingenious Mr Pennant. Nor can we omit the flattering mention which Mr Gray makes of him in one of his letters, dated from London in 1761: " I have lately made an acquaintance with this philoſopher, who lives in a garret here in the winter, that he may ſupport ſome near relations who depend upon him. He is always employed, conſequently (according to my old maxim)

maxim) always happy, always cheerful, and seems to me a very worthy honest man. His present scheme is to send some persons, properly qualified, to reside a year or two in Attica, to make themselves acquainted with the climate, productions, and natural history of the country, that we may understand Aristotle, Theophrastus, &c. who have been heathen Greek to us for so many ages; and this he has got proposed to Lord Bute, no unlikely person to put it in execution, as he is himself a botanist."

Mr Stillingfleet published a volume of miscellaneous tracts, which is in much esteem, and does great honour to his head and heart. They are chiefly translations of some essays in the *Amœnitates Academicæ*, published by Linnæus, interspersed with some observations and additions of his own. In this volume he shows also a taste for classical learning, and entertains us with some elegant poetical effusions of his own. But his Essay on Conversation, published in the first volume of Dodsley's Collection of Poems, entitles him to a distinguished rank among our English poets. This poem is addressed to Mr Wyndham, with all that warmth of friendship which distinguishes Mr Stillingfleet. As it is chiefly didactic, it does not admit of so many ornaments as some compositions of other kinds. However, it contains much good sense, shows a considerable knowledge of mankind, and has several passages that in point of harmony and easy versification would not disgrace the writings of our most admired poets. Here more than once Mr Stillingfleet shows himself still sore for Dr Bentley's cruel treatment of him; and towards the beautiful and moral close of it (where it is supposed he gives us a sketch of himself) seems to hint at a mortification of a more delicate nature, which he is said to have suffered from the other sex.

To these disappointments it was perhaps owing that Mr Stillingfleet neither married nor went into orders. His London residence was at a saddler's in Piccadilly; where he died in 1771, aged above 70, leaving several valuable papers behind him. He was buried in St James's church, without the slightest monument to his memory.

STILLINGIA, a genus of plants belonging to the class monœcia, and to the order of *monadelphia*. See BOTANY *Index*.

STILYARD. See *STEEL-Yard*.

STILPO, a celebrated philosopher of Megara, flourished under the reign of Ptolemy Euergetes. In his youth he had been addicted to licentious pleasures, from which he religiously refrained from the moment that he ranked himself among philosophers. When Ptolemy Soter, at the taking of Megara, offered him a large sum of money, and requested that he would accompany him into Egypt, he accepted but a small part of the offer, and retired to the island of Ægina, whence, on Ptolemy's departure, he returned to Megara. That city being again taken by Demetrius the son of Antigonus, and the philosopher required to give an account of any effects which he had lost during the hurry of the plunder, he replied, that he had lost nothing; for no one could take from him his learning and eloquence. So great was the fame of Stilpo, that the most eminent philosophers of Athens took pleasure in attending upon his discourses. His peculiar doctrines were, that species or universals have no real existence, and that one thing cannot be predicated of another. With respect to the former of these opinions, he seems to have taught the same doctrine with the sect afterwards known by the appellation of *Nominalists*. To prove that one thing cannot be predicated of another, he said, that *goodness* and *man*, for instance, are different things, which cannot be confounded by asserting the one to be the other: he argued farther, that goodness is an universal, and universals have no real existence; consequently since nothing cannot be predicated of any thing, goodness cannot be predicated of man. Thus, whilst this subtle logician was, through his whole argument, predicating one thing of another, he denied that any one thing could be the accident or predicate of another. If Stilpo was serious in this reasoning; if he meant any thing more than to expose the sophistry of the schools, he must be confessed to have been an eminent master of the art of wrangling; and it was not wholly without reason that Glycera, a celebrated courtezan, when she was reproved by him as a corrupter of youth, replied, that the charge might be justly retorted upon himself, who spent his time in filling their heads with sophistical quibbles and useless subtleties. In ethics he seems to have been a Stoic, and in religion he had a public and a private doctrine, the former for the multitude, and the latter for his friends. He admitted the existence of a supreme divinity, but had no reverence for the Grecian superstitions.

Enfield's History of Philosophy, vol. i.

STILOBATUM, in *Architecture*, denotes the body of the pedestal of any column.

STILTON, a town of England, in Huntingdonshire, 75 miles from London, south-west of Yaxley, on the Roman highway from Castor to Huntingdon, called *Ermine street*, some parts of which, in this neighbourhood, appear still paved with stone. This place is famous for cheese called *English Parmesan*, which is generally kept till it is old before it is brought to table, and even the process of decay is accelerated by various means, to render it agreeable to a vitiated taste. For making Stilton cheese, the following receipt is given in the first volume of the *Repository of Arts and Manufactures*:

"Take the night's cream, and put it to the morning's new milk, with the rennet; when the curd is come, it is not to be broken, as is done with other cheeses, but take it out with a soil-dish altogether, and place it in a sieve to drain gradually; and as it drains, keep gradually pressing it till it becomes firm and dry; then place it in a wooden hoop; afterwards to be kept dry on boards, turned frequently, with cloth binders round it, which are to be tightened as occasion requires, and changed every day until the cheese become firm enough to support itself; after the cloth is taken off, the cheese is rubbed every day all over, for two or three months, with a brush; and if the weather be damp or moist twice a-day; and even before the cloth is taken off, the top and bottom are well rubbed every day."

STIMULANTS, in *Medicine*, substances which increase the action of certain parts of the body. In particular, they quicken the motion of the blood, increase the action of the muscular fibres, and affect the nervous system.

STIMULI, in *Botany*, a species of armature or offensive weapon, with which some plants, as nettle, cassada, da, acalypha, and tragia, are furnished. Their use, says Linnæus, is by their venomous punctures to keep off naked animals that would approach to hurt them.

STING, an apparatus in the bodies of certain insects, in form of a little spear, serving them as a weapon of offence.

STING-Ray. See RAIA, ICHTHYOLOGY *Index*.

Falconer's Marine Dictionary. STINK-POT, an earthen jar or shell, charged with powder, grenadoes, and other materials of an offensive and suffocating smell. It is frequently used by privateers, in the western ocean, in the attack of an enemy whom he designs to board; for which purpose it is furnished with a light fuse at the opening or touch-hole. See BOARDING.

STINT, a species of bird. See TRINGA, ORNITHOLOGY *Index*.

STIPA, FEATHER GRASS, a genus of plants belonging to the class triandria, and order of digynia; and in the natural system ranging under the 4th order, *Gramina*. See BOTANY *Index*.

STIPEND, among the Romans, signifies the same with tribute; and hence *stipendarii* were the same with *tributarii*.

STIPEND, in *Scots Law*. See LAW, § clix. 12.

STIPULA, in *Botany*, one of the fulcra or props of plants, defined by Linnæus to be a scale, or small leaf, stationed on each side the base of the footstalks of the flower and leaves, at their first appearance, for the purpose of support. Elmgren restricts it to the footstalks of the leaves only.

STIPULATION, in the civil law, the act of stipulating, that is, of treating and concluding terms and conditions to be inserted in a contract. Stipulations were anciently performed at Rome, with abundance of ceremonies; the first whereof was, that one party should interrogate, and the other answer, to give his consent, and oblige himself. By the ancient Roman law, nobody could stipulate but for himself; but as the tabelliones were public servants, they were allowed to stipulate for their masters; and the notaries succeeding the tabelliones have inherited the same privilege.

STIRIA, a province of Germany, in the circle of Austria, with the title of a duchy. It is bounded on the north by the archduchy of Austria, on the east by Hungary, on the south by Carniola, and on the west by Carinthia and the archbishopric of Saltsburg; it is 125 miles in length and 17 in breadth, and is said to contain 22 cities, 95 towns, 338 castles, 15 convents, and 200,000 inhabitants. Though it is a mountainous country, yet there is a great deal of land fit for tillage, and the soil is so good, that the inhabitants never were in want of corn. It contains mines of very good iron; whence the arms made there are in great esteem. The women differ greatly from the Austrians, and are very plain and ingenious. They have all swellings on their throats, called *bronchoceles*. The men are also very simple, and are rather disposed to indulge in indolence. The chief town is Gratz.

STIRLING, a town of Scotland, situated on the river Forth, 35 miles north-west of Edinburgh, in W. Long. 3. 59. N. Lat. 56. 6. It is also called *Sterling* and *Striveling*; from the former of which Boethius falsely derives the name *Sterling money*; because, says he, Osbrit, a Saxon prince, after the overthrow of the Scots, established a mint there. The name of *Striveling* is said to have been derived from the frequency of strifes or conflicts in the neighbourhood. The town contains about 4000 inhabitants. It has a manufacture of tartans and shalloons, and employs about 30 looms in that of carpets. The great street is very broad. In it is the tolbooth, where is kept the standard for the wet measures of Scotland. The other streets are narrow and irregular.—Stirling is in miniature a resemblance of Edinburgh; being built on a rock of the same form, with a fortress on the summit. The origin of the castle is unknown. The rock of Stirling was strongly fortified by the Picts, amongst whom architecture and several other useful arts had made a considerable progress. As it lay in the extremities of their kingdom, the possession of it was the occasion of frequent contests betwixt them and their neighbours the Scots and Northumbrians; each of whose dominions did, for some time, terminate near it.

When the Scots, under Kenneth II. overthrew the Pictish empire near the middle of the ninth century, they endeavoured to obliterate every memorial of that people. They not only gave new names to provinces and towns, but, with all the rage of barbarians, demolished many magnificent and useful edifices which had been reared up by them, and this fortress among the rest. It was, however, soon rebuilt, though upon an occasion not very honourable to the Scots.

Upon the death of Kenneth II. in 855, his brother Donald V. mounted the throne of Scotland. In the beginning of his reign the kingdom was invaded by Osbrecht and Ella, two Northumbrian princes, who, uniting their forces with the Cumbrian Britons, and a number of Picts, who upon their expulsion from their native country had taken refuge in England, advanced to Jedburgh, where Donald encountered them; and, after a fierce and bloody battle, obtained a complete victory: but, having taken up his station in Berwick, in supine security, the Northumbrians, informed of the careless posture in which the Scottish army lay, surprised them by a hasty march, dispersed them, and made a prisoner of the king. Pursuing the advantage they had gained, they marched northward, and subdued all before them to the frith of Forth and the town of Stirling. But the forlorn situation of the Scots, without a king and without an army, obliging them to sue for peace, they obtained it, upon condition that they should pay a sum of money for the ransom of the king, and yield up all their dominions upon the south side of the Forth to the conquerors.

The Northumbrians taking possession of the territories ceded to them by this treaty, rebuilt the castle of Stirling, and planted it with a strong garrison, in order to preserve their new conquests, upon the frontiers of which it was situated. Our authorities also inform us, that they erected a stone bridge over the Forth, upon the summit of which a cross was raised, with the following inscription in monkish rhyme.

Anglos a Scotis separat crux ista remotis;
Armis hic stant Bruti, Scoti stant hic, cruce tuti.

Which is thus translated by Bellenden.

I am free marche, as passengeris may ken,
To Scottis, to Britonis, and to Inglismen.

None of the ancient English historians mentions this conquest. The whole story, as well as the inscription, wears

Stirling. wears much of a monkish garb; yet its authenticity is not a little confirmed by the arms of the town of Stirling, upon which is a bridge, with a cross, and the last line of the above Latin distich is the motto round it.

We must not, however, imagine, that in those times that fortress bore any resemblance to the present structure, which is adapted to the use of fire-arms. Its size and form probably resembled those castles which, under the feudal constitution, the English and Scottish barons used to erect upon their estates for dwelling-houses; and which, in those barbarous ages, they found necessary to fortify for their defence, not only against foreign invaders, but often against the attacks of their own neighbours. It is directly such a Gothic figure as this which represents the *Castrum Strivelense* upon the arms of Stirling.

This fortress, after it had continued in the possession of the Northumbrian Saxons about 20 years, was, together with the whole country upon the south side of the Forth, restored to the Scots, upon condition of their assisting the Saxons against their turbulent invaders the Danes. Upon the arms of Stirling are two branches of a tree, to represent the *Nemus Strivelense*; but the situation and boundaries of that forest, which was probably a wing of the Caledonian, cannot be ascertained. Upon the south of Stirling, vestiges of a forest are still discernible for several miles. Banks of natural timber still remain in the castle park, at Murray's wood, and near Nether Bannockburn; and stumps of trees, with much brushwood, are to be seen in all the adjacent fields.

When Kenneth III. received intelligence of the Danes having invaded his dominions, he appointed the castle of Stirling to be the place of rendezvous for his army; and he marched from thence to the battle of Loncarty, where he obtained a victory over those rovers, in the end of the 10th century.

In the 12th century, this castle is spoken of as a place of great importance, and one of the strongest fortresses in the kingdom. In 1174, a calamity, not unusual amongst the Scottish monarchs, befel William, who at that time occupied the throne. He was taken prisoner in an unsuccessful expedition which he made into England; and, after having been detained 12 months in captivity, was released, upon stipulating to pay a large sum of money for his ransom; and, until payment thereof, delivering into the hands of the English the four principal fortresses in the kingdom, which in those days were Stirling, Edinburgh, Roxburgh, and Berwick. This was the first great ascendant that England obtained over Scotland; and indeed the most important transaction which had passed between these kingdoms from the Norman conquest.

Though the Scottish monarchs, in their frequent perambulations through the kingdom, often visited Stirling, and held their courts for some time in the castle; yet it did not become a royal residence till the family of Stuart mounted the throne, and it was from different princes of this family that it received its present form. It was the place of the nativity of James II.; and, when raised to the throne, he frequently kept his court in it. It is well known to have been the place where that prince perpetrated an atrocious deed, the murder of William earl of Douglas, whom he stabbed with his own hand. The royal apartments were at that time in the north-west corner of the castle, and are now the residence of the fort-major. The room where the murder was committed still goes by the name of *Douglas's room*.

James III. contracting a fondness for the castle on account of its pleasant situation, made it the chief place of his residence, and added several embellishments to it. He built within it a magnificent hall, which in those days was deemed a noble structure, and is still entire. It now goes by the name of the *parliament-house*, having been designed for the accommodation of that supreme court. It was covered with an oaken roof of exquisite workmanship, which, though very little decayed, was a few years ago removed to make way for one of more modern structure. James also erected a college of secular priests in the castle, which he called the *chapel royal*, and which proved one cause of his own ruin. As the expences necessary for maintaining the numerous officers of such an institution were considerable, he annexed to it the revenues of the rich priory of Coldingham in the Merse, which at that time happened to become vacant. This priory had for a long time been holden by persons connected with the family of Hume; and that family, considering it as belonging to them, strongly opposed the annexation. The dispute seems to have lasted several years; for one parliament had passed a vote, annexing the priory to the chapel-royal, and a subsequent one enacted a statute prohibiting every attempt that was contrary or prejudicial to that annexation.

James V. was crowned in the castle of Stirling; and the palace, which is the chief ornament of it, was the work of that prince. This is a stately and commodious structure, all of hewn stone, with much statuary work upon it. It is built in form of a square, with a small court in the middle, in which the king's lions are said to have been kept; and hence it still goes by the name of the *lions den*. The palace contains many large and elegant apartments; the ground-story is now converted into barrack-rooms for the soldiers of the garrison; the upper affords a house for the governor, with lodgings for some of the subaltern officers.

Opposite to the palace, upon the north, stands an elegant chapel, which was built by James VI. for the baptism of his son, Prince Henry, in 1594. In this chapel is preserved the hulk of a large boat, which that whimsical monarch caused to be built and placed upon carriages, in order to convey into the castle the provisions for that solemnity.

A strong battery, with a tier of guns pointing to the bridge over the Forth, was erected during the regency of Mary of Lorraine, mother to Queen Mary. It is called the *French battery*, probably because constructed by engineers of that nation. The last addition was made to the fortifications in the reign of Queen Anne. Formerly they reached no farther than the old gate, upon which the flag-staff now stands: but in that reign they were considerably enlarged upon the side towards the town; and barracks, which are bomb-proof, with several other conveniences for a siege, were erected.

Upon the south side of the castle lies a park inclosed with a stone-wall, called the *king's park*, and near to the foot of the rock on which the castle stands, lay the royal gardens; vestiges of the walks and parterres, with a few stumps of fruit-trees, are still visible; but by long neglect, and the natural wetness of the soil, the place is now

now little better than a marsh. In the gardens is a mount of earth in form of a table, with benches of earth around it, where, according to tradition, the court sometimes held *fetes-champetres*. In the castle-hill is an hollow, comprehending about an acre of ground, and having all the appearance of an artificial work, which was used for jousts, tournaments, and other feats of chivalry.

Northward of the castle lies the Govan, or perhaps more properly the *Gowling* hill (A); in the middle of which is a small mount called *Hurly Haaky*, upon which Duke Mardoch and his two sons were executed for treasonable practices in the reign of James I.

The prospect from the castle is most delightful, as well as extensive, being greatly beautified, especially upon the east, by the windings of the Forth; which are so numerous, that though the distance by land from Stirling to Alloa is, in a straight line, not quite six miles, it is said to be 24 by water. As this river generally runs upon plain ground, it rolls its stream in so slow and silent a manner, that what Silius Italicus saith of the Ticinus is applicable to it, if, instead of *lucenti* in that poet, we should read *lutoso*; for the clay-banks, together with the tide, which flows above Stirling, render the Forth perpetually muddy:

> *Vix credas labi, ripis tam mitis opacis*
> *Somniferam ducit* lutolo *gurgite lympham.*

The lordship and castle of Stirling were a part of the usual dowry of the queens of Scotland, at least after the family of Stuart came to the throne, in which they were invested at their marriage.

Robert lord Erskine was appointed governor of the castle by King David II. and the office continued in that family till 1715.

This fortress hath been the scene of many transactions. Being by its situation considered as a key to the northern parts of the kingdom, the possession of it hath been always esteemed of great importance to those who sought to be masters of Scotland. It was undoubtedly a place of strength when the art of war by ordnance was in its infancy; but though it resisted the utmost efforts of the rebels in 1746, it could not now hold out three days if besieged by an army of a few thousand men conducted by an engineer of knowledge and integrity.

STIRLINGSHIRE, a county of Scotland, of which Stirling is the capital. It extends 20 miles in length and 12 in breadth; being bounded on the west by part of Lennox and Clydesdale; on the east, by Clackmannanshire, the river Forth, and part of Lothian; on the south-east, by Lothian; and on the north by Monteith. The face of the country is open and agreeable, diversified by hill and dale, well watered with streams and rivers; the principal of which is the Forth, rising in the neighbourhood of a high mountain called *Ben-Lomond*, and, running eastward, forms the frith of Edinburgh. The southern part is hilly, affording plenty of game, and pasturage for sheep, horses, and black cattle. The eastern part is fertile, producing plentiful harvests of corn, and great abundance of coal. Lead-ore is found in different parts of the county; and the rivers abound with pike, trout, and salmon.

The population of this county at two different periods, and according to the different parishes, will be seen in the following table:

	Parishes.	Population in 1755.	Population in 1790—1798.
	Airth	2316	2350
	Alva	436	612
	Baldernock	621	620
	Balfron	755	1381
5	Bothkennar	529	600
	Buchanan	1699	1111
	Campsie	1399	2517
	Denny	1392	1400
	Drymen	2789	1607
10	Falkirk	3932	8020
	Fintry	891	543
	Gargunnock	956	830
	Killearn	959	973
	Kilsyth	1395	2450
15	Kippen	1799	1777
	Larbert and Dunipace	1864	4000
	Muiravonside	1539	1065
	Polmont	1094	1400
	St Ninians	6491	7079
20	Slamannan	1209	1010
	Stirling	3951	4698
	Strathblane	797	620
		38,813	46,663
			38,813
		Increase,	7850*

* Statist. Hist. of Scotland.

STIRRUP, in the manege, a rest or support for the horseman's foot, for enabling him to mount, and for keeping him firm in his seat.

Stirrups were unknown to the ancients. The want of them in getting upon horseback was supplied by agility or art. Some horses were taught to stoop to take their riders up; but the riders often leapt up by the help of their spears, or were assisted by their slaves, or made use of ladders for the purpose. Gracchus filled the highways with stones, which were intended to answer the same end. The same was also required of the surveyors of the roads in Greece as part of their duty.

Menage observes, that St Jerome is the first author who mentions them. But the passage alluded to is not to be found in his epistles; and if it were there, it would prove nothing, because St Jerome lived at a time when stirrups are supposed to have been invented, and after the use of saddles. Montfaucon denies the authenticity of this passage; and, in order to account for the ignorance of the ancients with regard to an instrument so useful and so easy of invention, he observes, that while cloths and housings only were laid upon the horses backs, on which the riders were to sit, stirrups could not have been used, because they could not have been fastened with the same security as upon a saddle. But it is more

Berenger's History and Art of Horsemanship, vol. i. p. 65.

(A) So called from the wailings and lamentations (in Scotch, *gowlings*) that were made for Duke Murdoch.

more probable, that in this inſtance, as in many others, the progreſs of human genius and invention is uncertain and ſlow, depending frequently upon accidental cauſes.

STIRRUP of a Ship, a piece of timber put upon a ſhip's keel, when ſome of her keel happens to be beaten off, and they cannot come conveniently to put or fit in a new piece; then they patch in a piece of timber, and bind it on with an iron, which goes under the ſhip's keel, and comes up on each ſide of the ſhip, where it is nailed ſtrongly with ſpikes; and this they call a ſtirrup.

STOBÆUS, JOHN, a laborious Greek writer, who lived at the end of the fourth century, compoſed many works, of which there are only his Collections remaining, and even theſe are not as he compoſed them; many things being inſerted by later authors. This work contains many important ſentiments collected from the ancient writers, poets, and philoſophers.

STOCK, in gardening, &c. the ſtem or trunk of a tree. What ſtock is moſt proper for each kind of fruit, ought as well to be conſidered and known, as what ſoil is moſt ſuitable to trees; for on theſe two things the future vigour of trees, and the goodneſs of fruit, equally depend. The beſt way for thoſe who intend to plant, is to raiſe their own ſtocks, by which they will be better aſſured of what they do; but if they ſhould buy their trees of nurſerymen, they ſhould diligently inquire upon what ſtocks they were propagated. See GRAFTING.

STOCK, in trade. See *CAPITAL Stock*.

STOCK-Broker. See BROKER and STOCKS.

STOCK-Dove. See COLUMBA, ORNITHOLOGY *Index*.

STOCK-Jobbing, the art or myſtery of trafficking in the public ſtocks or funds. See FUND and *Stock-JOBBING*.

STOCK Gilly-flower. See CHEIRANTHUS, BOTANY *Index*.

STOCKHOLM, the capital of Sweden, is ſituated in the province of Upland, in E. Long. 19. 30. and N. Lat. 59. 20. Its foundation is by the beſt Swediſh writers generally attributed to Birger Jarl, regent of the kingdom about the middle of the 13th century during the minority of his ſon Waldemar, who had been raiſed to the throne by the ſtates of the kingdom; but it was not before the 18th century that the royal reſidence was transferred from Upſala to this city.

This capital, which is very long and irregular, occupies, beſide two peninſulas, ſeven ſmall rocky iſlands, ſcattered in the Mæler, in the ſtreams which iſſue from that lake, and in a bay of the gulf of Bothnia. A variety of contraſted and enchanting views are formed by numberleſs rocks of granite riſing boldly from the ſurface of the water, partly bare and craggy, partly dotted with houſes, or feathered with wood. The harbour is an inlet of the Baltic: the water is clear as cryſtal, and of ſuch depth that ſhips of the largeſt burthen can approach the quay, which is of conſiderable breadth, and lined with ſpacious buildings and ware houſes. At the extremity of the harbour ſeveral ſtreets riſe one above another in the form of an amphitheatre; and the palace, a magnificent building, crowns the ſummit. Towards the ſea, about two or three miles from the town, the harbour is contracted into a narrow ſtrait, and, winding among high rocks, diſappears from the ſight; and the proſpect is terminated by diſtant hills, overſpread with foreſt. It is far beyond the power of words, or of the pencil, to delineate theſe ſingular views. The central iſland, from which the city derives its name, and the Ritterholm, are the handſomeſt parts of the town. Excepting in the ſuburbs, where the houſes are of wood painted red, the generality of the buildings are of ſtone, or brick ſtuccoed white. The royal palace, which ſtands in the centre of Stockholm, and upon the higheſt ſpot of ground, was begun by Charles XI.: it is a large quadrangular ſtone edifice, and the ſtyle of architecture is both elegant and magnificent.

Coxe's Travels, vol. ii.

It is the habitation not only of the royal family, but alſo of the greater part of the officers belonging to the houſehold. It likewiſe comprehends the national or ſupreme court of juſtice, the colleges of war, chancery, treaſury, and commerce; a chapel, armoury, library, and office for the public records; but the greater number of inferior officers and ſervants belonging to the court, are, with the foot-guards, quartered on the burghers. The caſtle, and all the ſtately edifices in the kingdom, are covered with copper. The palace of the nobility, in which this order ſits during the ſeſſion of the diet, is an elegant building adorned on the outſide with marble ſtatues and columns, and on the inſide with painting and ſculpture. This and three other palaces ſtand on the banks of the lake, and are built on the ſame model, ſo as to compoſe an uniform piece of architecture. The bank, built at the expence of the city, is a noble edifice, and joins with many ſumptuous houſes belonging to the nobility in exhibiting a ſplendid appearance. The houſes of the burghers are generally built of brick in the city; but in the ſuburbs they are commonly made up of timber, and therefore very ſubject to conflagrations. Theſe houſes are often framed in Finland, according to the plan and dimenſions preſcribed: whence they are tranſported in pieces to Stockholm by water, and there ſet up by the carpenters. Theſe wooden habitations, if kept in proper repair, will laſt 30 or 40 years, and are deemed warmer, neater, and more healthy, than thoſe of brick or ſtone. To prevent the danger of conflagrations, the city is divided into 12 wards. In each of theſe there is a maſter and four aſſiſtants, who forthwith repair to the place where the fire breaks out; and all porters and labourers are obliged to range themſelves under the maſter of the ward to which they belong. A fire-watch patroles the ſtreets by night, to give warning or aſſiſtance as it may be wanted; and a centinel is maintained in the ſteeple of every church, to toll the bell on the firſt appearance of any ſuch accident. The police of Stockholm is entirely ſubjected to the regulations of the grand governor, aſſiſted by a deputy and bailiff of the caſtle. This city is the emporium of Sweden, to which all the commodities of the kingdom are brought for exportation, and where almoſt all the imports from abroad are depoſited. The port or haven formed by the lake Mæler is large enough to contain 1000 ſail of ſhipping; and furniſhed with a key or wharf about an Engliſh mile in length, to which the veſſels may lie with their broadſides. The greateſt inconveniences attending this ſituation are, the diſtance from the ſea, which is not within leſs than 10 miles of the town; the want of tides; and the winding of the river, which is remarkably crooked. It opens into the Baltic; and the entrance, which is dangerous and rocky, the Swedes have ſecured with two ſmall forts: within, it is perfectly ſafe and commodious.

dious. The northern ſuburbs are remarkable for the king's gardens, and for the great number of artiſans who have choſen their habitations in this quarter. In the ſouthern ſuburbs the Muſcovite commodities are ſold; and here is a magnificent exchange where the merchants daily aſſemble. Population 80,000.

STOCKING, that part of the clothing of the leg and foot which immediately covers and ſcreens them from the rigour of the cold. Anciently, the only ſtockings in uſe were made of cloth, or of milled ſtuffs ſewed together; but ſince the invention of knitting and weaving ſtockings of ſilk, wool, cotton, thread, &c. the uſe of cloth ſtockings is quite diſcontinued. Dr Howel, in his Hiſtory of the World (vol. ii. p. 222.) relates, that Queen Elizabeth, in 1501, was preſented with a pair of black knit ſilk ſtockings by her ſilk-woman, and thenceforth ſhe never wore cloth ones any more. The ſame author adds, that King Henry VIII. ordinarily wore cloth hoſe, except there came from Spain, by great chance, a pair of ſilk ſtockings. His ſon, King Edward VI. was preſented with a pair of long Spaniſh ſilk ſtockings by Sir Thomas Greſham, and the preſent was then much taken notice of. Hence it ſhould ſeem, that the invention of ſilk knit ſtockings originally came from Spain. Others relate, that one William Rider, an apprentice on London bridge, ſeeing at the houſe of an Italian merchant a pair of knit worſted ſtockings from Mantua, took the hint, and made a pair exactly like them, which he preſented to William earl of Pembroke, and that they were the firſt of that kind worn in England, anno 1564.

The modern ſtockings, whether woven or knit, are formed of an infinite number of little knots, called *ſtitches*, *lo ps*, or *meſhes*, intermingled in one another.

Knit ſtockings are wrought with needles made of poliſhed iron or braſs wire, which interweave the threads and form the meſhes the ſtocking conſiſts of. At what time the art of knitting was invented it is perhaps impoſſible to determine, though it has uſually been attributed to the Scots, as it is ſaid that the firſt works of this kind came from Scotland. It is added, that it was on this account that the company of ſtocking-knitters, eſtabliſhed at Paris 1527, took for their patron St Fiacre, who is ſaid to have been the ſon of a king of Scotland. But it is moſt probable that the method of knitting ſtockings by wires or needles was firſt brought from Spain.

Woven ſtockings are generally very fine; they are manufactured on a frame or machine made of poliſhed iron, the ſtructure of which it is needleſs to deſcribe, as it may be ſeen in almoſt every conſiderable town in Great Britain. The invention of this machine is, by Mr Anderſon, attributed to Williaw Lee, M. A. of St John's College, Cambridge, at a period ſo early as 1589. Others have given the credit of this invention to a ſtudent of Oxford at a much later period, who, it is ſaid by Aaron Hill *, was driven to it by dire neceſſity. This young man, falling in love with an innkeeper's daughter, married her though ſhe had not a penny, and he by his marriage loſt a fellowſhip. They ſoon fell into extreme poverty; and their marriage producing the conſequences naturally to be expected from it, the amorous pair became miſerable, not ſo much on account of their ſufferings, as from the melancholy dread of what would become of their yet unborn infant. Their only means of ſupport were the knitting of ſtockings, at which the woman was very expert: "But ſitting conſtantly together from morning to night, and the ſcholar often fixing his eyes, with ſtedfaſt obſervation, on the motion of his wife's fingers in the dexterous management of her needles, he took it into his imagination, that it was not impoſſible to contrive a little loom which might do the work with much more expedition. This thought he communicated to his wife, and joining his head to her hands, the endeavour ſucceeded to their wiſh. Thus the ingenious ſtocking-loom, which is ſo common now, was firſt invented; by which he did not only make himſelf and his family happy, but has left his nation indebted to him for a benefit which enables us to export ſilk ſtockings in great quantities, and to a vaſt advantage, to thoſe very countries from whence before we uſed to bring them at conſiderable loſs in the balance of our traffic."

* See *An Account of the Riſe and Progreſs of the Beech Oil Invention*, &c. 8vo. 1715.

STOCKS, *or* Public Funds *in England.* By the word *ſtock* was originally meant a particular ſum of money contributed to the eſtabliſhing a fund to enable a company to carry on a certain trade, by means of which the perſon became a partner in that trade, and received a ſhare of the profit made thereby, in proportion to the money employed. But this term has been extended farther, though improperly, to ſignify any ſum of money which has been lent to the government, on condition of receiving a certain intereſt till the money is repaid, and which makes a part of the national debt. As the ſecurity both of the government and of the public companies is eſteemed preferable to that of any private perſon, as the ſtocks are negociable and may be ſold at any time, and as the intereſt is always punctually paid when due; ſo they are thereby enabled to borrow money on a lower intereſt than what could be obtained from lending it to private perſons, where there muſt be always ſome danger of loſing both principal and intereſt.

But as every capital ſtock or fund of a company is raiſed for a particular purpoſe, and limited by parliament to a certain ſum, it neceſſarily follows, that when that fund is completed, no ſtock can be bought of the company; though ſhares already purchaſed may be transferred from one perſon to another. This being the caſe, there is frequently a great diſproportion between the original value of the ſhares and what is given for them when transferred: for if there are more buyers than ſellers, a perſon who is indifferent about ſelling will not part with his ſhare without a conſiderable profit to himſelf; and on the contrary, if many are diſpoſed to ſell, and few inclined to buy, the value of ſuch ſhares will naturally fall in proportion to the impatience of thoſe who want to turn their ſtock into ſpecie.

A ſtock may likewiſe be affected by the court of chancery: for if that court ſhould order the money, which is under their direction, to be laid out in any particular ſtock, that ſtock, by having more purchaſers, will be raiſed to a higher price than any other of the like value.

By what has been ſaid, the reader will perceive how much the credit and intereſt of the nation depends on the ſupport of the public funds. While the annuities and intereſt for money advanced is there regularly paid, and the principal inſured by both prince and people (a security not to be had in other nations, foreigners will lend us their property, and all Europe be interested in our welfare; the paper of the companies will be converted into money and merchandise, and Great Britain can never want cash to carry her schemes into execution. See the article FUND.

STOCKS, a frame erected on the shore of a river or harbour, whereon to build shipping. It generally consists of a number of wooden blocks, ranged parallel to each other, at convenient distances, and with a gradual declivity towards the water.

STOCKS, a wooden machine to put the legs of offenders in, for securing disorderly persons, and by way of punishment in divers cases, ordained by statute, &c.

STOCKTON upon Tees, a handsome town in the county of Durham, about 16 miles south of the city of Durham. It is now a port of considerable trade; though, at the restoration, it was a despicable village, the best house in which could hardly boast of any thing better than clay-walls and a thatched roof. About 40 years ago it sent out in one year 75 vessels for the port of London; and the trade is much increased since.

STOEBE, BASTARD ÆTHIOPIAN, a genus of plants belonging to the class syngenesia; and in the natural system ranging under the 49th order *compositæ*. See BOTANY *Index*.

STOKESIA, a genus of plants belonging to the syngenesia class, and order of polygamia æqualis. The corollets in the ray are disposed in the shape of a funnel, and are long and irregular. The down is four-bristled, and the receptacle is naked. One species only is known, which is a herbaceous plant, and a native of South Carolina.

STOICS, the name given to a sect of Grecian philosophers, from Στοα, "the porch in Athens," which the founder of the sect chose for his school. For the peculiar tenets of this sect, see METAPHYSICS, Chap. iv. Part 3. MORAL PHILOSOPHY, n° 8. and ZENO.

STOLBERG, a small town of Germany, in the circle of Upper Saxony, and territory of Thuringia, of which it is the capital place. It is situated between two mountains, 50 miles north-west of Leipsic. E. Long. 11. 8. N. Lat. 51. 42.

STOLE, a sacerdotal ornament worn by the Romish parish priests above their surplice, as a mark of superiority in their respective churches; and by other priests over the alb, at celebrating of mass, in which case it goes across the stomach; and by deacons, over the left shoulder, scarf-wise: when the priest reads the gospel for any one, he lays the bottom of his stole on his head. The stole is a broad swath, or slip of stuff, hanging from the neck to the feet, with three crosses thereon.

Groom of the STOLE, the eldest gentleman of his Majesty's bedchamber, whose office it is to present and put on his Majesty's first garment, or shirt, every morning, and to order the things in the chamber.

STOMACH, in *Anatomy*. See ANATOMY, n° 91.

STOMACHIC MEDICINES are such as strengthen the stomach and promote digestion, &c.

Stomachic corroboratives are such as strengthen the tone of the stomach and intestines; among which are carminatives, as the roots of galangals, red gentian, zedoary, pimpinella, calamus aromaticus, and arum. Of barks and rinds, those of canella alba, sassafras, citrons, Seville and China oranges, &c. Of spices, pepper, ginger, cloves, cinnamon, cardamums, and mace.

STOMOXYS, a genus of insects belonging to the order of diptera. See ENTOMOLOGY, p. 214.

STONE, EDMUND, a distinguished self-taught mathematician, was born in Scotland; but neither the place nor the time of his birth is well known; nor have we any memoirs of his life, except a letter from the Chevalier de Ramsay, author of the Travels of Cyrus, in a letter to Father Castel, a Jesuit at Paris, and published in the Memoirs de Trevoux, p. 109, as follows: "True genius overcomes all the disadvantages of birth, fortune, and education; of which Mr Stone is a rare example. Born a son of a gardener of the duke of Argyle, he arrived at eight years of age before he learnt to read.—By chance a servant having taught young Stone the letters of the alphabet, there needed nothing more to discover and expand his genius. He applied himself to study, and he arrived at the knowledge of the most sublime geometry and analysis, without a master, without a conductor, without any other guide but pure genius.

"At 18 years of age he had made these considerable advances without being known, and without knowing himself the prodigies of his acquisitions. The duke of Argyle, who joined to his military talents a general knowledge of every science that adorns the mind of a man of his rank, walking one day in his garden, saw lying on the grass a Latin copy of Sir Isaac Newton's celebrated *Principia*. He called some one to him to take and carry it back to his library. Our young gardener told him that the book belonged to him. 'To you?' replied the duke. 'Do you understand geometry, Latin, Newton?' I know a little of them, replied the young man with an air of simplicity arising from a profound ignorance of his own knowledge and talents. The duke was surprised; and having a taste for the sciences, he entered into a conversation with the young mathematician: he asked him several questions, and was astonished at the force, the accuracy, and the candour of his answers. 'But how (said the duke) came you by the knowledge of all these things?' Stone replied, 'A servant taught me, ten years since, to read: Does one need to know any thing more than the 24 letters in order to learn every thing else that one wishes?' The duke's curiosity redoubled—he sat down upon a bank, and requested a detail of all his proceedings in becoming so learned.

"I first learned to read, said Stone: the masons were then at work upon your house: I went near them one day, and I saw that the architect used a rule, compasses, and that he made calculations. I inquired what might be the meaning and use of these things; and I was informed that there was a science called Arithmetic: I purchased a book of arithmetic, and I learned it.—I was told there was another science called Geometry: I bought the books, and I learnt geometry. By reading I found that there were good books in these two sciences in Latin: I bought a dictionary, and I learned Latin. I understood also that there were good books of the same kind in French: I bought a dictionary, and I learned French. And this, my lord, is what I have done: it seems to me that we may learn every thing when we know the 24 letters of the alphabet."

"This account charmed the Duke. He drew this wonderful

wonderful genius out of his obfcurity; and he provided him with an employment which left him plenty of time to apply himfelf to the fciences. He difcovered in him alfo the fame genius for mufic, for painting, for architecture, for all the fciences which depend on calculations and proportions."

"I have feen Mr Stone. He is a man of great fimplicity. He is at prefent fenfible of his own knowledge; but he is not puffed up with it. He is poffeffed with a pure and difinterefted love for the mathematics, though he is not folicitous to pafs for a mathematician; vanity having no part in the great labour he fuftains to excell in that fcience. He defpifes fortune alfo; and he has folicited me twenty times to requeft the duke to give him lefs employment, which may not be worth the half of that he now has, in order to be more retired, and lefs taken off from his favourite ftudies. He difcovers fometimes, by methods of his own, truths which others have difcovered before him. He is charmed to find on thefe occafions that he is not a firft inventor, and that others have made a greater progrefs than he thought. Far from being a plagiary, he attributes ingenious folutions, which he gives to certain problems, to the hints he has found in others, although the connection is but very diftant," &c.

Mr Stone was author and tranflator of feveral ufeful works; viz. 1. A New Mathematical Dictionary, in 1 vol. 8vo, firft printed in 1726. 2. Fluxions, in 1 vol. 8vo, 1730. The Direct Method is a tranflation from the French, of Hofpital's Analyfe des Infiniments Petits; and the Inverfe Method was fupplied by Stone himfelf. 3. The Elements of Euclid, in 2 vols. 8vo, 1731. A neat and ufeful edition of thofe Elements, with an account of the life and writings of Euclid, and a defence of his Elements againft modern objectors. Befide other fmaller works. Stone was a fellow of the Royal Society, and had inferted in the Philofophical Tranfactions (vol. xli. p. 218), an "Account of two fpecies of lines of the 3d order, not mentioned by Sir Ifaac Newton or Mr Stirling."

STONE, *Jerome*, the fon of a reputable feaman, was born in the parifh of Scoonie, in the county of Fife, North Britain. His father died abroad when he was but three years of age, and his mother, with her young family, was left in very narrow circumftances. Jerome, like the reft of the children, having got the ordinary fchool education, reading Englifh, writing, and arithmetic, betook himfelf to the bufinefs of a travelling chapman. But the dealing in buckles, garters, and fuch fmall articles, not fuiting his fuperior genius, he foon converted his little ftock into books, and for fome years went through the country, and attended the fairs as an itinerant bookfeller. There is great reafon to believe that he engaged in this new fpecies of traffic, more with a view to the improvement of his mind than for any pecuniary emolument. Formed by nature for literature, he poffeffed a peculiar talent for acquiring languages with amazing facility. Whether from a defire to underftand the Scriptures in their original languages, or from being informed that thefe languages are the parents of many others, he began his philological purfuits with the ftudy of the Hebrew and Greek tongues; and, by a wonderful effort of genius and application, made himfelf fo far mafter of thefe, without any kind of affiftance, as to be able to interpret the Hebrew Bible and Greek Teftament into Englifh *ad aperturam libri*. At this time he did not know one word of Latin. Senfible that he could make no great progrefs in learning, without the knowledge of at leaft the grammar of that language, he made application to the parifh fchoolmafter for his affiftance. Some time afterwards, he was encouraged to profecute his ftudies at the univerfity of St Andrews. An unexampled proficiency in every branch of literature recommended him to the efteem of the profeffors; and an uncommon fund of wit and pleafantry rendered him, at the fame time, the favourite of all his fellow ftudents, fome of whom fpeak of him to this day with an enthufiaftic degree of admiration and refpect. About this period fome very humorous poetical pieces of his compofition were publifhed in the Scots Magazine. Before he had finifhed his third feffion, or term, at St Andrew's, on an application to the college by the mafter of the fchool of Dunkeld for an ufher, Mr Stone was recommended as the beft qualified for that office; and about two or three years after, the mafter being removed to Perth, Mr Stone, by the favour of his Grace the Duke of Atholl, who had conceived a high opinion of his abilities, was appointed his fucceffor.

When he firft went to Dunkeld, he entertained but an unfavourable opinion of the Gaelic language, which he confidered as nothing better than a barbarous inarticulate gibberifh; but being bent on inveftigating the origin and defcent of the ancient Scots, he fuffered not his prejudices to make him neglect the ftudy of their primitive tongue. Having, with his ufual affiduity and fuccefs, maftered the grammatical difficulties which he encountered, he fet himfelf to difcover fomething of the true genius and character of the language. He collected a number of ancient poems, the production of Irifh or Scottifh bards, which, he faid, were daring, innocent, paffionate, and bold. Some of thefe poems were tranflated into Englifh verfe, which feveral perfons now alive have feen in manufcript, before Mr Macpherfon publifhed any of his tranflations from Offian.

He died while he was writing and preparing for the prefs a treatife, intitled, "An Inquiry into the Original of the Nation and Language of the ancient Scots, with Conjectures about the Primitive State of the Celtic and other European Nations;" an idea which could not have been conceived by an ordinary genius. In this treatife he proves that the Scots drew their original, as well as their language, from the ancient Gauls. Had Mr Stone lived to finifh this work, which difcovers great ingenuity, immenfe reading, and indefatigable induftry, it would have thrown light upon the dark and early periods of the Scottifh hiftory, as he opens a new and plain path for leading us through the unexplored labyrinths of antiquity. But a fever put an end to his life, his labours, and his ufefulnefs, in the year 1757, being then only in the 30th year of his age. He left, in manufcript, a much efteemed and well-known allegory, intitled "The Immortality of Authors," which has been publifhed and often reprinted fince his death, and will be a lafting monument of a lively fancy, found judgement, and correct tafte. It was no fmall ornament of this extraordinary character, that he paid a pious regard to his aged mother, who furvived him two years, and received an annual penfion from the Duchefs of Atholl as a teftimony of refpect to the memory of her fon.

STONEHIVE,

STONEHIVE, or STONEHAVEN, a ſmall town in the county of Kincardine, in Scotland, 15 miles ſouth from Aberdeen. It was built in the time of Charles II. and ſtands at the foot of ſome high cliffs, in a ſmall bay, with a rocky bottom, opening a little in one part, ſo that ſmall veſſels may find admittance, but only at high water. A pier runs out from the harbour on the north ſide to ſecure them after their entrance. The town contains about 800 inhabitants. The manufactures are ſail-cloths and oſnaburghs, knit worſted and thread ſtockings.

STONES, in *Natural Hiſtory*, have been defined bodies which are inſipid, not ductile, nor inflammable, nor ſoluble in water. For a view of the claſſification of ſtones and of their diſtribution, ſee MINERALOGY and GEOLOGY.

Here we ſhall make a few obſervations on ſome ſpeculative diſcuſſions relative to their natural hiſtory.

As philoſophers have perplexed themſelves much about the origin and formation of the earth (a ſubject certainly far beyond the ken of the human intellect, at leaſt if we believe that it was made by the Almighty power of God), ſo they have alſo propoſed theories to explain the origin of ſtones. When philoſophers limit their inquiries within the boundaries of ſcience, where they are led by the ſober and ſafe conduct of obſervation and experiment, their concluſions may be ſolid and may be uſeful; but when, throwing experiment and obſervation aſide, they rear a theory upon an airy nothing, or upon a ſingle detached fact, their theories will vaniſh before the touch of true philoſophy as a romantic palace before the rod of the enchanter. Sometimes from whim, or caprice, or vanity, they attempt to confound every thing: they wiſh to prove that the ſoul is mere matter, that plants are animals, and that foſſils are plants, and thus would baniſh two ſubſtances, ſpirit and dead matter, entirely from the world; as if the Author of Nature were actuated by ſordid views of parſimony in the works of creation, though we evidently ſee that a generous profuſion is one of the characteriſtic marks of theſe works. We leave the taſk of confounding the different claſſes of being to thoſe philoſophers whoſe minds are too contracted to comprehend a great variety of being at one view, or who prefer novelty to every thing elſe. We content ourſelves with the old opinion, that the ſoul is a ſpiritual ſubſtance; that plants are plants, and that ſtones are ſtones.

We have been led into theſe remarks by finding that ſome philoſophers ſay that ſtones are vegetables; that they grow and increaſe in ſize like a plant. This theory, we believe, was firſt offered to the world by M. Tournefort, in the year 1702, after returning from his travels in the eaſt. It was founded on a curious fact. In ſurveying the labyrinth of Crete, he obſerved that the names which viſitors had engraved upon the rock were not formed of hollow but of prominent letters like baſſo relievos. He ſuppoſes that theſe letters were at firſt hollowed out by knives; that the hollows have ſince been filled up by the growth of the ſtone; and hence he concludes that ſtones vegetate. We wiſh we were fully aſſured of the fact that the letters were at firſt hollowed, before we attempt to account for their prominency. But even allowing the ſuppoſition to be true that they were at firſt hollow, we reply it is only a ſingle fact, and that it is altogether unphiloſophical to deduce a general ſyſtem from a ſingle fact.

In the *ſecond* place, this protuberancy of the characters is very improperly called vegetation, for it is not produced by a proceſs in any reſpect like the vegetation of a plant. Vegetation ſuppoſes veſſels containing fluids and growth by expanſion; but who ever heard of veſſels in a ſtone, of fluids moving in them, or of the different parts expanding and ſwelling like the branch or trunk of a tree? Even the fact which Tournefort mentions proves nothing. He does not pretend to ſay, that the rock itſelf is increaſing, but only that a few ſmall hollows are filled with new ſtony matter, which riſes a little above the ſurrounding ſurface of the rock. This matter evidently has been once liquid, and at length has congealed in the channel into which it had run. But is not this eaſily explained by a common proceſs, the formation of ſtalactites? When water charged with calcareous matter is expoſed to the action of air, the water evaporates, and leaves the calcareous earth behind, which hardens and becomes like a ſtone.

Having thus examined the principal fact upon which M. Tournefort founds his theory, it is unneceſſary to follow him minutely through the reſt of his ſubject.—He compares the accretion of matter in the labyrinth to the conſolidation of a bone when broken, by a callus formed of the extravaſated nutritious juice. This obſervation is thought to be confirmed, by finding that the projecting matter of the letters is whitiſh and the rock itſelf greyiſh. But it is eaſy to find compariſons. The difficulty, as Pope ſays, is to apply them. The reſemblance between the filling up of the hollow of a ſtone, and the conſolidation of a broken bone by a callus, we confeſs ourſelves not philoſophers enough to ſee. Were we writing poetry in bad taſte, perhaps it might appear. The circumſtance, that the prominent matter of the letters is whitiſh, while the rock is greyiſh, we flatter ourſelves ſtrengthens our ſuppoſition that it conſiſts of a depoſition of calcareous matter. Upon the whole, we conclude, we hope logically, that no ſuch theory as this, that ſtones are vegetables, can be drawn from the ſuppoſed fact reſpecting the labyrinth. We have to regret, that the account which we have ſeen of the ſubject is ſo imperfect, that we have not ſufficient materials for a proper inveſtigation. Tournefort has not even told us of what kind of ſtone or earth the accretion conſiſts; yet this ſingle information would probably have decided the queſtion (A).

(A) To give a more diſtinct notion of Tournefort's theory, we ſhall ſubjoin his concluſions: From theſe obſervations (he ſays) it follows, that there are ſtones which grow in the quarries, and of conſequence that are fed; that the ſame juice which nouriſhes them ſerves to rejoin their parts when broken; juſt as in the bones of animals, and the branches of trees, when kept up by bandages; and, in a word, that they vegetate. There is, then (he ſays), no room to doubt but that they are organized; or that they draw their nutritious juice from the

STONES AND EARTHS, Analysis of.

Preliminary Processes.

AT the close of our article Mineralogy, we referred to this place for an account of the method of examining the chemical conſtitution of earths and ſtones. In the article Ores, we have given a pretty full detail of the methods of analyſing that claſs of minerals. In this place we propoſe briefly to point out the moſt improved proceſſes for the analyſis of the other three claſſes of mineral bodies, viz. earths and ſtones, ſalts, and combuſtibles; to which we ſhall add ſome account of the method of examining ſoils.

But before proceeding to the immediate object of this treatiſe, it may be uſeful to make ſome obſervations on ſome preliminary proceſſes connected with the ſubject under conſideration.

In the firſt place, it is neceſſary that the mineral to be examined be reduced to a fine powder. To effect this with very hard ſtones, they are made red hot, and in this ſtate thrown into cold water. By the ſudden change of temperature in the different parts of the ſtone, it cracks, and falls to pieces. If the pieces be not ſufficiently ſmall, the ſame proceſs is to be repeated. The fragments are then to be reduced to ſmaller pieces in a poliſhed ſteel mortar, and the cavity of this mortar ought to be cylindrical. A peſtle of the ſame metal ſhould be made to fit it exactly, that no part of the ſtone may eſcape during the operation of pounding. The ſtone being in this way reduced to powder, a determinate quantity is taken, 100 or 200 grains, for example, and this is to be reduced to as fine a powder as poſſible; or, as it is called, to an impalpable powder. This operation is moſt ſucceſsfully performed in an agate mortar, with a peſtle of the ſame mineral; a mortar of about four inches in diameter, and rather more than one inch deep, is found to anſwer the purpoſe very well. It is found moſt convenient to operate on ſmall quantities only at a time; not more than five or ſix grains. When the powder feels ſoft, adheres, and appears under the peſtle in the form of a cake, it is then as fine as poſſible. It is now to be accurately weighed, and it is uſually found to have acquired ſome additional weight, ariſing from part of the mortar being worn off during the pounding. This additional weight muſt be attended to, and after the analyſis is completed, a part of the ſubſtance of the mortar muſt be ſubtracted. In the caſe of an agate or flint mortar being uſed, the portion rubbed off, which increaſes the weight, may be regarded as pure ſiliceous earth.

The chemical veſſels neceſſary for the analyſis of minerals are crucibles for expoſing the ſubſtances to heat, glaſſes and ſhallow diſhes for ſolutions and evaporations. The crucibles ſhould be of platina or pure ſilver, and of ſuch a capacity as to hold from ſeven to eight cubic inches of water. The veſſels in which the ſolutions, evaporations, and other proceſſes are performed, ſhould be of glaſs or porcelain; the glaſs veſſels, as being more brittle, and therefore more apt to break, are found to be leſs economical than thoſe of porcelain. Some chemiſts employ porcelain veſſels which are in the form of ſections of ſpheres, and are glazed both in the inſide and outſide, excepting part of the bottom, which comes into immediate contact with the fire. Wedgewood's glazed veſſels for evaporations, are found to anſwer very well; the glaze is thin, and the veſſels are not very apt to crack; but it is ſuppoſed by ſome chemiſts, that it is occaſionally acted on by ſtrong acids. It is ſcarcely neceſſary to add, that an accurate balance is a neceſſary inſtrument in the hands of the analyſt.

I. *Of the Analyſis of Earths and Stones.*

The ingredients which have been diſcovered by means of analyſis, in the compoſition of ſimple ſtones are, ſilica, alumina, lime, magneſia, zirconia, and glucina, with ſome of the metallic oxides, as thoſe of iron, copper, mangeneſe, chromium, and nickel; but it never happens that the whole of theſe ſubſtances are found in combination; and indeed it is a rare circumſtance to meet with more than four or five in the ſame ſtone. With a view of diſcovering the different ſubſtances which enter into the compoſition of ſtones, the following method is recommended.

Take 200 grains of the ſtone to be examined, or, if it be inconvenient to procure this quantity, 100 grains will be ſufficient. Let it be reduced to a fine powder, mixed with three times its weight of pure potaſh, and a ſmall portion of water, and then ſubjected to heat in a crucible of ſilver. The heat muſt be applied ſlowly at firſt, and the matter is to be conſtantly ſtirred, that no part of it may be thrown out of the crucible by the ſwelling of the potaſh. The water being evaporated, the mixture is to be kept at a red heat for half an hour; and being removed from the furnace, ſome notion may be formed of the nature of the ingredients, by examining the contents; for, if the mixture be in a liquid ſtate, the ſtone is chiefly compoſed of ſiliceous earth; if it be of the conſiſtence of paſte, and have an opaque appearance,

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the earth. This juice muſt be firſt filtrated and prepared in their ſurface, which may be here eſteemed as a kind of bark; and hence it muſt be conveyed to all the other parts. It is highly probable the juice which filled the cavities of the letters was brought thither from the bottom of the roots; nor is there any more difficulty in conceiving this than in comprehending how the ſap ſhould paſs from the roots of our largeſt oaks to the very extremities of their higheſt branches. Some ſtones, then (he concludes), muſt be allowed to vegetate and grow like plants: but this is not all; (he adds), that probably they are generated in the ſame manner; at leaſt, that there are abundance of ſtones whoſe generation is inconceivable, without ſuppoſing that they come from a kind of ſeeds, wherein the organical parts of the ſtones are wrapped up as thoſe of the largeſt plants are in their ſeeds.

Preliminary Processes.

ance, the other earths predominate; but if it remain in a powdery form, the aluminous earth is in greatest proportion. The oxides of different metals are indicated by the colour of the mass; when it is of a dark or brownish red, the metallic oxide is that of iron; a grass green colour denotes manganese; and yellowish green the oxide of chromium.

But there are some stones on which potash has a very feeble action, and in this case borax has been substituted for the alkali. This is the method which was followed by Mr Chenevix in analysing aluminous stones. A hundred grains of sapphire in powder were mixed with 250 grains of calcined borax, and subjected to a strong heat in a crucible of platina for two hours. When the mass was cold, it exhibited the appearance of a greenish blue glass, which adhered strongly to the crucible; but the whole being boiled for some hours in muriatic acid, it was completely dissolved; the earthy matter was then precipitated by means of sub-carbonate of ammonia, and the precipitate, after being well washed, was again dissolved in muriatic acid; and in this way the borax was separated. The remaining part of the analysis was nearly similar to that directed for other stones, excepting only that the alumina was separated from the potash by means of muriate of ammonia.

But to return to the examination and farther treatment of the mass in the silver crucible, which after being removed from the furnace, and wiped on the outside, is to be placed in a porcelain capsule; it is then filled with water, and this water is renewed occasionally, till the whole matter is separated from the crucible. By this means a part of the compound of the alkali with the siliceous and aluminous earths, is dissolved, and with a sufficient quantity of water, the whole may be dissolved. Muriatic acid is now to be added till the whole of the mass is brought to a state of solution. This, however, will not be the case, if the stone be composed chiefly of silica. On the first addition of the acid, a flakey precipitate is produced, because the acid unites with the alkali, which held the mass in solution. An effervescence afterwards takes place, which arises from the decomposition of a portion of carbonate of potash, formed during the fusion; and the flakey precipitate is again dissolved, as well as the matter which remained in the form of powder at the bottom of the vessel. If the powder be silica and alumina, there is no effervescence; but if it contain lime, an effervescence is produced. The solution in the muriatic acid being formed, if it shall appear colourless, it may be inferred that it contains no metallic oxide, or at least a very small portion. An orange red colour shews that it contains iron, a purplish red indicates manganese, and a golden yellow, chromium.

The solution is now to be introduced into an evaporating dish of porcelain, and being covered with paper, is to be placed on a sand bath, and evaporated to dryness. Towards the end of the evaporation, as the liquid assumes the form of a jelly, it must be constantly stirred with a rod of silver or porcelain, to permit the acid and water to pass off, and to allow the whole mass to be equally dried; for it is in this way that the silica and alumina are separated from each other. The matter being reduced to a dry powder, add to it a large quantity of pure water, expose it to a moderate heat, and pour it on a filter. This solution may be denominated A. Wash repeatedly the powder which remains upon the filter, till the water with which it is washed no longer precipitates silver from its solutions. The powder remaining is siliceous earth, which is first to be dried between folds of blotting paper, and then made red hot in a crucible of platina or silver; and when it is cold it is to be accurately weighed. If it be pure siliceous earth, it is in the form of a white powder, is of a white colour, does not adhere to the fingers, and is insoluble in acids. If it be at all coloured, it shews that it contains some metallic oxide, and is a proof that the evaporation has been carried on with too great a heat. To separate the oxide, boil the silica with an acid, and then wash and dry it as before. This acid solution is to be added to the solution A, and the whole is to be evaporated to about the quantity of an English pint; then add to it a solution of carbonate of potash, till the precipitation ceases; and it may be necessary to boil it a few moments, to allow the whole of the precipitate to fall to the bottom. The whole of the precipitate being collected at the bottom, the supernatant liquid is decanted off, and the water being put in its place, the precipitate and water are thrown on a filter; and when the water has run off, the filter with the precipitate upon it is placed on the folds of blotting paper. After the precipitate has acquired some degree of consistence, collect it carefully with an ivory knife, mix it with a solution of pure potash, and boil it in a capsule of porcelain. The potash dissolves the alumina or glucina, and the other substances remain in the form of a powder. This powder may be called B.

Add to the solution of potash as much acid as will saturate the potash, and also redissolve any precipitate which at first appeared; and then add carbonate of ammonia till the taste of it be perceptible in the liquid. The whole of the alumina is now precipitated in the form of white flakes, while the glucina remains dissolved, if a sufficient quantity of carbonate of ammonia had been employed. Filter the liquid; and the alumina remaining on the filter being washed and dried, and after being made red hot, and allowed to cool, is weighed. To prove its being alumina, dissolve it in sulphuric acid, and a sufficient quantity of sulphate or acetate of potash being added, the whole of it will be converted into alum crystals, if the earth employed be aluminous earth.

To separate the glucina, the liquid which passed through the filter is to be boiled for some time, and if the solution contain any of this earth it will be precipitated in the form of a light powder, which may be dried in the usual manner, and weighed. It is a fine, soft, light, tasteless powder, when in a state of purity; and the application of heat does not make it concrete, as happens to alumina.

We now return to the residuum B, in which may be expected lime, magnesia, and some of the metallic oxides. But if it be suspected that this residuum contains any yttria, it is to be treated with carbonate of ammonia, which dissolves the yttria, and leaves the other bodies untouched. The yttria being separated, the residuum B is to be dissolved in weak sulphuric acid, and the solution evaporated to dryness. Add a small quantity of water, which will dissolve the sulphate of magnesia, as well as the metallic sulphates; but the sulphate of lime remains undissolved, or if any part of it should dissolve, Preliminary Processes.

dissolve, it may be thrown down by adding a small portion of weak alcohol. After being made red hot in a crucible, it is to be weighed, and the lime will amount to $\frac{42}{100}$ of the weight. The solution containing the remaining sulphates being diluted with a large portion of water, a small excess of acid is to be added, and then a saturated carbonate of potash. The magnesia and oxide of manganese remain dissolved, and the oxides of chromium, iron, and nickel, are precipitated. This precipitate may be denominated C.

Add to the solution a solution of hydrosulphuret of potash, and the manganese in the state of a hydrosulphuret will be precipitated. Calcine the precipitate in contact with air, and weigh it. The addition of pure potash to the solution will precipitate the magnesia, which being washed, and subjected to a red heat, is also to be weighed.

The residuum C is to be repeatedly boiled with nitric acid, and then mixed with pure potash; and, being heated, the liquid is to be decanted off. The precipitate thus obtained, consisting of the oxides of iron and nickel, is to be washed with pure water, and this water is to be added to the solution of the nitric acid and potash. The chromium, if any be present, is contained in that solution, and is in the form of an acid. Add to the solution muriatic acid in excess, and let the evaporation be continued till the liquor become of a green colour; then add a pure alkali, by which the chromium is precipitated in the state of oxide, which is to be dried in the usual way, and weighed.

The precipitate containing the oxides of iron and nickel is to be dissolved in muriatic acid; ammonia is to be added in excess, when the oxide of iron precipitates; and being collected, washed and dried, is to be weighed. By evaporating the solution, the oxide of nickel will be also precipitated, or the whole may be precipitated by the addition of hydrosulphuret of ammonia. This being treated in the same manner as the other substances, is also to be weighed.

The weight of the whole substances thus obtained being added together, and being compared with the weight of the matter originally operated upon, if the two be equal, or if the difference do not exceed three or four parts in 100, it may be inferred that the analysis is nearly correct; but a considerable loss of weight indicates some error, and requires the analysis to be carefully repeated. If the same loss of weight appear, it may be concluded that the stone contained some substance which is soluble in water, or has been driven off by the heat. To ascertain the last point, a portion of the stone is to be broken into small pieces, and exposed to a strong heat, in a porcelain retort. If it contain water, or any volatile substance, it will come over into the receiver, and by this means the nature and weight of the ingredients separated may be ascertained. If nothing come over into the receiver, or if what is obtained be not equal to the deficient weight, it may be inferred that the stone contains some matter which is soluble in water.

A fixed alkali has been not unfrequently found in simple stones; and to ascertain whether the mineral subjected to analysis contains any alkaline matter, different methods have been pursued. These methods we shall now describe. The stone being reduced to an impalpable powder, is cautiously heated repeatedly with sulphuric acid, and the mass is to be digested in water; and this solution being properly concentrated, is set aside for some days. The appearance of crystals of alum is a certain indication that the mineral contained potash; and the quantity of potash may be estimated at $\frac{100}{1000}$ of the weight of those crystals; but if no crystals be obtained, the solution is to be evaporated to dryness, and the residuum exposed to a moderate red heat. Digest it afterwards in water, and add carbonate of ammonia, and filter; evaporate again to dryness, expose the residue to a heat of 700°, and redissolve it. The solution being properly concentrated, will give crystals of sulphate of soda or of potash, as the one or the other alkali is present. Potash may be discovered by adding to the solution of the salt, a solution of nitro-muriate of platina somewhat concentrated. A yellow precipitate, which is muriate of platina and potash, is thus obtained.

Klaproth's method for discovering fixed alkalies in minerals is the following. He takes four parts of nitrate of barytes to one of the mineral to be examined, and fuses them together in a porcelain crucible. A spongy mass of a light-blue colour was thus obtained, and with the addition of diluted muriatic acid, was completely dissolved. The solution, which was of a yellow colour, was then mixed with a sufficient quantity of sulphuric acid, by which the barytes is precipitated, and the muriatic acid expelled. The liquid is next evaporated to dryness, and the mass being digested in water, is filtered, and the sulphate of barytes and silica remain on the filter. The clear solution is saturated with carbonate of ammonia, and filtered a second time; and all the earthy and metallic bodies being separated, the sulphates of fixed alkali and ammonia only remain in the solution, which being evaporated to dryness, the dry saline mass is introduced into a porcelain crucible, and subjected to such a degree of heat as is sufficient to drive off the sulphate of ammonia. The residuum is then dissolved in water, and crystallized; and thus a pure, fixed alkaline sulphate is obtained, which is again dissolved in water, and decomposed, by adding acetate of barytes. The solution is then filtered, and the liquid is evaporated to dryness. The saline mass obtained is the acetate of a fixed alkali, which being exposed to heat in a crucible, became of a reddish colour. The carbonaceous residuum is then to be dissolved in water, filtered, and crystallized, and the salt thus procured is a carbonate of a fixed alkali, the nature of which may be easily recognised by the means stated above.

Mr Davy's method of detecting a fixed alkali in minerals, is different *. One hundred grains of the stone in very fine powder are to be fused for half an hour at a strong red heat, in a crucible of platina or silver, with 200 grains of boracic acid. An ounce and half of nitric acid diluted with seven or eight times its quantity of water, is then digested upon the fused mass, till the decomposition of the whole is completed. Evaporate the fluid to about two ounces, or one ounce and a half; by this means the siliceous earth is separated, which being collected on a filter, is to be washed with distilled water, till the boracic acid and the whole of the saline matter are separated. The fluid is then mixed with water that has passed through the filter, and evaporated to the quantity of half a pint, after which it is saturated with carbonate of ammonia, and boiled with an excess of this salt, till the whole of the substances capable of being

* Nichol. Journ. xiii. 86.

Zircon Genus.

being precipitated, have been thrown down. The ſolution being filtered, the earths and metallic oxides remain on the filter. Add nitric acid to the liquid till it acquire a ſtrong ſour taſte, and evaporate till the boracic acid appear free.

The fluid is then to be filtered, and evaporated to dryneſs, and the dry maſs being expoſed to a heat of about 450° Fahrenheit, the nitrate of ammonia is decompoſed, and the nitrate of potaſh or ſoda remains behind.

To detect fluoric acid, which has been ſometimes met with as a component part of ſtones, Klaproth heats the mineral with ſulphuric acid in a glaſs retort, the corroſion of which, and the depoſition of ſilica in the water of the receiver, are certain teſts of fluoric acid.

After the general obſervations which have now been offered, we proceed to give examples of the analyſis of minerals belonging to the different genera of earths and ſtones; and we ſhall follow the ſame order in which thoſe genera are deſcribed in the article MINERALOGY.

1. ZIRCON Genus.

The mineral affording the earth which characteriſes this genus, was analyſed by Klaproth in the following manner *. We ſelect that ſpecies which is called hyacinth.

* Eſſays, i. 195.

A. 100 grains of hyacinth being levigated in the flint-mortar, received an increaſe of weight of half a grain.

B. This pulverized hyacinth, digeſted with two ounces of nitro-muriatic acid, yielded, upon ſaturating the ſolution with potaſh, a light-brown precipitate, of three grains and a half, when dried. Ammonia, added to it, diſſolved nothing; and it remained colourleſs. After the precipitate had been again ſeparated from the volatile alkali, muriatic acid was added, which diſſolved its ferruginous contents, leaving a white earth behind, which, when ignited, weighed 1½ grain. The portion of iron, precipitated by cauſtic ammonia from the muriatic ſolution, weighed half a grain, when ignited, and became black and reſplendent. It was fuſed with a neutral phoſphate, upon charcoal, to find whether it contained mangaueſe; no trace was perceptible.

C. The above 1½ grains of earth B were now added again to the hyacinth, after treatment with acids. The ſtone was then ſubjected to red heat, with ſix times its quantity of cauſtic alkali, in the manner explained in the eſſay on the jargon of Ceylon; the ignited maſs was again liquefied with water; and the earth remaining after this proceſs weighed 123 grains, when collected, edulcorated, and dried.

D. The alkaline lixivium was then ſaturated with muriatic acid, and evaporated. At firſt it continued clear; but towards the end ſiliceous earth ſeparated, the quantity of which, after ignition, amounted to ſix grains.

E. To the 123 grains, previouſly well waſhed with water, a ſufficient quantity of muriatic acid was added; which, with the aſſiſtance of heat, diſſolved nearly the whole, a trifling reſidue excepted. This muriatic ſolution, evaporated in a moderate heat to a ſixth or eighth part, loſt its fluidity, and formed a limpid gelatinous coagulum. It was then covered with water, and expoſed, with repeated agitation, to a digeſting heat.

Siliceous Genus.

By this management, the ſiliceous earth ſeparated in ſlimy, intumeſced grains, and weighed, after ignition, 23¼ grains.

F. The ſolution, thus freed from its ſilica, was now ſaturated with a boiling ley of mild alkali; and the precipitate was waſhed and dried in the air. This laſt weighed 114 grains, proving, upon every trial, to be jargonic earth. A fourth part of it, heated to redneſs, weighed 16½ grains; which make the whole amount to 66 grains.

G. The above ſix grains D, with the 23¼ grains E, in the whole 29¼ grains of ſiliceous earth, were ignited with a quadruple weight of vegetable alkali. When this maſs had been again ſoftened with water, it left a reſidue, which was extracted by muriatic acid. From this muriatic ſolution, alſo, when ſaturated with potaſh, jargonic earth fell down, weighing four grains after ignition. Hence, ſubtracting theſe, the quantity of ſiliceous earth is reduced to 25¼ grains.

One hundred parts of hyacinth, therefore, have given

Jargonia -	F	66	70
	G	4	
Silica -	G	25¼	
Subtract	A	¼	
			25
Oxide of iron	B	-	0.50
			95.50
		Loſs	4.50
			100

2. Of the SILICEOUS Genus.

A great proportion of the ſtones belonging to this genus are tranſparent, and have a vitreous appearance. They are ſo hard as to ſcratch glaſs, and, excepting the fluoric acid, they are not acted upon by acids. By fuſion with alkalies they form glaſs; they alſo enter into fuſion with boracic acid, and the acid of phoſphorus. Stones compoſed chiefly of pure ſilica, are tranſparent and colourleſs. When a mineral is preſented for examination, even if it poſſeſs moſt of the properties which characterize ſtones belonging to this genus, ſome preliminary proceſſes may be purſued to aſcertain farther its nature and component parts.

A. It is ſometimes difficult to reduce ſiliceous ſtones to a fine powder. To facilitate this operation, a a portion of the ſtone may be heated to redneſs, and in this ſtate ſuddenly plunged into cold water. If by the firſt heating it is not ſufficiently brittle, the operation may be repeated until the mineral can be reduced to a fine powder, as already directed.

B. One part of the ſtone in fine powder is now to be mixed with four or five parts of potaſh, diſſolved in the ſame quantity of water. The mixture is introduced into a ſilver crucible, and evaporated to dryneſs, ſtirring it conſtantly with a ſilver rod, according to the directions given above. The maſs being evaporated to dryneſs, the heat is to be gradually increaſed, till the crucible appears of a dull red heat, or till the maſs enter into quiet fuſion. In this ſtate it is kept for an hour.

C. Remove the crucible from the fire before it is completely cold; ſoften the maſs with water, by adding freſh

Siliceous Genus.

fresh portions from time to time, till the whole is detached from the crucible, and then add 12 times its bulk of water to effect a solution. If the stone consisted chiefly of siliceous earth, the greater part of the mass will be dissolved.

D. Add muriatic acid till no farther precipitate is effected, and without separating the precipitate, evaporate the whole to dryness.

E. Pour six times its bulk of muriatic acid, previously diluted with four parts of water, on the dry mass; boil the mixture for half an hour; let the insoluble part subside, and then collect it on a filter, and after being dried, subject it in a crucible to a red heat. This powder is the siliceous earth contained in the mineral.

But stones included under this genus contain very different proportions, not only of siliceous earth, but also of the other earths; and some of them even contain a far greater proportion of other earths than that which characterizes the genus under which they are arranged.

Analysis of Leucite.

The analysis of this mineral is particularly interesting, not only as Klaproth first detected in it potash, which was supposed to belong exclusively to the vegetable kingdom, and hence called vegetable alkali, but also as it places the skill and address of that eminent chemist in its examination in a very conspicuous light. The process was conducted in the following manner*.

* *Essays,* i. 348.

Ignited alone upon charcoal, the leucite is completely infusible. It undergoes no manner of alteration, and its splinters lose nothing of their lustre.

A small fragment, put into fused borax, is for a long time moved about in it before it dissolves, which it does by degrees; and the glass globule obtained is clear and light-brown.

By fusion with a neutral phosphate, the solution is still slower, and a colourless rifty glass pearl is produced.

One hundred grains of coarsely pounded leucite exposed for an hour to a strong red heat, in a small porcelain pot, lost of weight only one-eighth of a grain, and even the violent heat of the porcelain furnace produced in the leucite only an inconsiderable change.

A. One hundred grains of leucite, reduced to an impalpable powder, being several times digested in muriatic acid, dissolved a considerable part. A siliceous residue of 54 grains remained after ignition.

B. The siliceous earth ignited with twice its weight of caustic alkali, softened again with water, covered with muriatic acid, added to excess of saturation, and, after sufficient digestion with this last, being collected on the filter, and heated to redness, was found to have lost little of its weight.

C. Prussiate of potash added to the muriatic solution produced a precipitate which indicated one-eighth of a grain of oxide of iron.

D. The solution by caustic ammonia being decomposed, and the precipitate being separated, the remaining liquor was tried with carbonate of soda, but no farther change was effected.

E. The precipitate produced by means of pure ammonia D was first dried. It was next purified by digesting it with distilled vinegar, and afterwards neutralizing this acid by ammonia. It weighed 24 grains and a half, when edulcorated and ignited. Diluted sulphuric acid completely dissolved it to a limpid liquor, and when properly treated, the solution yielded only alum.

Siliceous Genus.

F. To obtain the earth, which possibly might have remained latent in the several washings, the whole were evaporated to dryness. After having re-dissolved the saline mass in water, the remaining portion of earth was collected, it amounted only to half a grain, and was siliceous earth.

There were therefore obtained,

Silica	- (A)	54		
——	- (F)	$\frac{1}{2}$		
		$54\frac{1}{2}$	-	54.50
Alumina	- (E)	-	-	24.50
				79
		Loss		21
				100

The remarkable loss of more than one-fifth of the whole weight of the mineral under examination, excited suspicion that some error had crept into the analysis, and led to a repetition of the experiments, by varying the processes as follows.

A. One hundred grains of leucite in fine powder were ignited for half an hour, with double their weight of caustic potash. To the mass softened with water muriatic acid was added, just to the point of saturation, and the mixture being filtered, the remaining undissolved residuum was washed and dried.

B. The mineral thus prepared for decomposition, was then treated with muriatic acid, and kept for some time at a boiling heat. By this process a quantity of silica separated, which after being heated to redness weighed 54 grains and a half.

C. Oxalate of potash being added to the muriatic solution, concentrated by evaporation, produced no turbidity. The alumina was separated by the same means as in the former experiments, and its weight amounted to nearly the same. By other trials it did not appear to have any mixture of other earths, and no other earth could be obtained by evaporating the waters with which the powders had been washed.

Thus, after varying the experiments, the same results were obtained, and the same loss still appeared. In the farther prosecution of this investigation, the following experiments were had recourse to.

A. Two hundred grains of leucite in fine powder were repeatedly digested with muriatic acid, and the siliceous earth collected on the filter, washed, and weighed after being red hot, amounted to 109 grains.

B. The muriatic solution was of a yellowish colour, and being reduced by evaporation in a sand heat to the consistence of honey, the surface appeared covered with a saline crust; and when completely cooled, the mass appeared like a thick clear oil, of a golden yellow colour, and full of crystals, some of which were of a cubical, and some of a tabular form. The yellow fluid was gently poured off, and the salt rinsed with small portions of alcohol. The solution diluted with alcohol was again evaporated, and the small portion of salt thus obtained

tained was again waſhed with alcohol, and added to the firſt. The whole of the ſalt being dried, weighed 70 grains. This was diſſolved in water, and ſome drops of a ſolution of ammonia being added, threw down ſome particles of alumina. The ſolution being cryſtallized in a warm place, yielded only cubical cryſtals, ſome of which were elongated to four-ſided columns.

C. That part of the muriatic ſolution which ſhot into cryſtals being diluted with water, and decompoſed in a boiling heat, by carbonate of ſoda, yielded a precipitate, which after waſhing, drying, and ignition, amounted to $47\frac{1}{2}$ grains of aluminous earth. Three times its weight of concentrated ſulphuric acid was added, and the mixture was evaporated nearly to dryneſs. The maſs was again diſſolved in water, and combined with a ſolution of acetate of potaſh, which being cryſtallized, produced only alum.

D. The ſiliceous earth A was mixed with double its weight of potaſh, and ſubjected to a ſtrong red heat for an hour. The maſs was reduced to powder, and diluted with water. Muriatic acid was added in exceſs, and digeſted with it. The filtered muriatic ſolution being ſaturated with ſoda yielded $1\frac{1}{2}$ grain of aluminous earth, after which there remained of ſilica $107\frac{1}{2}$ grains.

The 200 grains of leucite have thus afforded of

	grs.
Silica D	107.50
Alumina C	47.75
——— D	1.55
	156.75

Here there was ſtill a deficiency of 43.25 grains, to account for which the 70 grains of ſalt B muſt be examined. This examination was conducted in the following manner.

1. The taſte and figure of the cryſtals were found to be the ſame with thoſe of muriate of potaſh.

2. The ſolution produced no change in vegetable blues, or in reddened litmus paper.

3. When heated to redneſs, the ſalt made a crackling noiſe, and remained fixed in the fire.

4. Neither carbonate of ſoda nor cauſtic ammonia produced any turbidity in the ſolution.

5. Two parts of ſtrong ſulphuric acid were added to three of the ſalt, and the muriatic acid being driven off by heat, the maſs was again diſſolved in water, which afforded cryſtals of ſulphate of potaſh.

6. The remaining portion of ſalt was diſſolved in a ſmall quantity of water, and to this was added a concentrated ſolution of cryſtallized acid of tartar. The acidulous tartrate of potaſh (cream of tartar) was thus immediately produced and precipitated in the form of ſand. This was waſhed, dried, burnt in a ſilver crucible, and the coal obtained repeatedly waſhed with water. The ſolution being evaporated to dryneſs, after being examined by the proper teſts, appeared to be a carbonate of potaſh, which being ſaturated with nitric acid, afforded nitrate of potaſh.

Thus it appears that the baſe of the 70 grains of ſalt conſiſted entirely of pure potaſh, which was neutralized by part of the muriatic acid employed in decompoſing the mineral; and according to the proportion of baſe in muriate of potaſh, the 70 grains A contain 42.7 grains of alkali; and in this way the deficiency in the examination of the leucite is accounted for.

The reſult of the analyſis is as follows.

	grs.
Silica	53.75
Alumina	24.62
Potaſh	21.35
	129.72

Analyſis of Pitchſtone.

The pitchſtone which is the ſubject of the following analyſis, alſo conducted by Klaproth, is the tranſparent yellowiſh or olive green variety of that mineral from Meiſſen. It affords an example of ſoda, the other fixed alkali, forming a component part of ſtones.

A. 100 grains in coarſe fragments were introduced into a covered crucible, and were ſubjected to a red heat for half an hour. When taken from the fire they appeared of a white gray mixed with a yellowiſh colour, and having a rough feel, with ſomething of the appearance of glazing. They loſt $8\frac{1}{2}$ grains of weight.

B. In the heat of a porcelain furnace, the pitchſtone was fuſed both in the clay and charcoal crucible, and was converted into a clear glaſs, full of ſmall froth holes.

C. 100 grains of pitchſtone in fine powder were treated with a ſolution of 200 grains of cauſtic ſoda, and being put into a ſilver crucible, were kept for half an hour in a pretty ſtrong red heat. The maſs was then ſoftened with water; muriatic acid was added in exceſs; the ſolution was evaporated in a ſand heat, nearly to dryneſs; water was again poured upon it, after which it was filtered, and 73 grains of ſiliceous earth were obtained.

D. Cauſtic ſoda was mixed in exceſs with the muriatic ſolution, and the whole was digeſted in a boiling heat, by which the precipitate formed at the beginning of the proceſs was again diſſolved; a brown reſiduum ſtill remained, which being ſeparated, the alkaline ſolution was neutralized, and precipitated with carbonate of ſoda. The precipitate, which was alumina, after being waſhed, dried, and heated to redneſs, amounted to $14\frac{1}{2}$ grains. The whole of it yielded cryſtals of alum, with ſulphuric acid and potaſh.

E. The reſiduum which remained undiſſolved by the cauſtic ſoda D, was firſt diſſolved in muriatic, and then united with ſulphuric acid. Sulphate of lime was obtained, which was collected, and waſhed with diluted alcohol. By reducing the filtered fluid by evaporation to a ſmaller quantity, and combining it with ſulphuric acid, another portion of ſulphate of lime, which, added to the firſt, amounted to three grains, indicating 18 grains of pure lime.

F. The fluid was now freed from the calcareous earth; the iron which it contained was precipitated by carbonate of ammonia, which amounted to one grain. The remaining fluid was evaporated to dryneſs, and water being added to the ſaline reſiduum, fine minute flocks of oxide of mangancſe ſeparated, but in no greater quantity than one-tenth of a grain.

G. 100 grains of pitchſtone in powder were mixed with 300 grains of cryſtallized nitrate of barytes, and heated to redneſs in a porcelain veſſel, till the ſalt was entirely

Argillaceous Genus.

entirely decompofed. The cold mafs was foftened with water, neutralized with muriatic acid, and combined in fuch proportion with fulphuric acid, that the latter, after the evaporation of the mixture, and feparation of the muriatic acid by heat, was ftill in excefs. The mafs was wafhed with hot water; the refiduum feparated by filtration; and the clear fluid was mixed with carbonate of ammonia in excefs. The precipitate thus obtained was collected on a filter, and the remaining fluid was evaporated to drynefs, and the portion of fulphate of ammonia fubjected to a moderate heat in a porcelain veffel, was driven off. A fixed falt remained, which appeared to be fulphate of foda. This was rediffolved, and decompofed by acetate of barytes; the filtered folution was evaporated to drynefs; the dry falt was heated to rednefs in a crucible of platina. The faline refiduum being rediffolved, filtered, and again evaporated to drynefs, yielded three grains of dry carbonate of foda, indicating $1\frac{3}{4}$ grain of pure foda. This being neutralized with nitric acid, gave cryftals of nitrate of foda.

The 100 grains of the mineral thus examined confift of

	grs.
Silica C	73.
Alumina D	14.5
Lime E	1.
Oxide of iron D	1.
——— manganefe D	.10
Soda G	1.75
Water A	8.50
	99.85

3. Argillaceous Genus.

As many of the ftones included under this genus are compofed of fimilar fubftances with thofe arranged in the former genus, it is obvious that the examination is to be conducted in the fame way. We fhall therefore give one example of the analyfis of a ftone belonging to this genus, and the example is that of bafalt by Klaproth *.

* Effays, ii. 195.

Analyfis of Bafalt.

A. Small fragments of this ftone were fubjected to a ftrong red heat for 30 minutes; the lofs of weight was two per cent. and the mafs became of a lighter colour, and more readily yielded to the peftle.

B. Bafalt expofed to the heat of a porcelain furnace in a common clay crucible, fufed into a compact black brown glafs, which in thin fplinters was tranfparent. It alfo entered into thin fufion in a crucible of femi-indurated fteatites; part of it ran into the clefts produced in the fteatites, and the reft was found cryftallized in brown fhining lamellæ, which on the furface were ftriated, and cellularly concreted. In a charcoal crucible it was converted into a dull gray and finely porous mafs, in which were inferted numerous grains of iron.

C. To afcertain whether this ftone contained foda, 100 grains of bafalt in fine powder were mixed with 400 grains of nitrate of barytes, and were at firft expofed in a large porcelain veffel to a moderate heat, and afterwards to a heat gradually raifed to ignition. The mixture fwelled up, and when the heat was increafed, white fumes arofe on uncovering the veffel, which led to a fuppofition that the foda was beginning to volatilize. The fire was then removed.

Argillaceous Genus.

D. The porous mafs, after cooling and being reduced to powder, was drenched with water, and treated with muriatic acid. The whole entered into folution, and produced a clear yellow fluid. The folution was evaporated, and fulphuric acid was added gradually, till it was in excefs. The fulphate of barytes was precipitated.

E. The faline mafs by filtration was reduced to drynefs, and water was added, the fediment feparated, and appeared to confift of the fulphate of barytes, and the filiceous earth of the ftone. The clear fluid was faturated with ammonia, and the precipitate which was obtained being filtered off, the neutralized liquor was evaporated to drynefs, and then expofed in a porcelain veffel to a moderately intenfe heat, till the whole fulphate of ammonia was driven off. The fixed portion remaining diffolved in water, and cryftallized, appeared to be pure fulphate of foda. This was diffolved, decompofed by acetate of barytes; the precipitate, which was fulphate of barytes, was feparated by the filter, and the clear fluid being evaporated to drynefs, the dry acetate of foda was heated to rednefs in a crucible of platina; and in this way $4\frac{1}{2}$ grains of dry carbonate of foda was obtained, which is equal to 2.6 grains of pure foda.

F. To feparate the other ingredients, 100 grains of powdered bafalt were ignited for two hours with 400 grains of carbonate of foda, in a crucible of porcelain; but with a degree of heat which did not produce fufion. It united into a yellowifh, fomewhat hard mafs, which being reduced to powder, and foftened with water, was neutralized with muriatic acid. It was then a little fuperfaturated with nitric acid, and evaporated to drynefs. The colour of the dry mafs was faffron yellow. It was diffufed in water, flightly acidulated with muriatic acid, and after being digefted for a fhort time it was filtered. The filiceous earth collected on the filter was expofed to a red heat, and being weighed, amounted to $44\frac{1}{2}$ grains.

G. The muriatic folution being fufficiently diluted with water, was precipitated at the temperature of boiling water, by means of carbonate of foda. The precipitate being feparated, was digefted with a folution of cauftic foda, and a dark brown refiduum was feparated by filtration. Muriatic acid was added in a fmall excefs to the alkaline fluid, and this was precipitated with carbonate of ammonia. The precipitate obtained, after being wafhed and ignited, amounted to $16\frac{1}{4}$ grains. It yielded alum, when treated with fulphuric acid and potafh, and was therefore aluminous earth.

H. The brown refiduum G was diffolved in muriatic acid with particular attention to the precife point of faturation. Succinate of ammonia was added to the folution, to precipitate the iron; and the fuccinate of iron obtained, when perfectly wafhed and ftrongly heated in a covered crucible, afforded 20 grains of oxide of iron, which were attracted by the magnet.

I. The iron being feparated, the fluid was treated at the temperature of boiling with carbonate of foda; a white precipitate was obtained, which was diffolved in nitric acid; and fulphuric acid being combined with the folution, threw down fulphate of lime. This was feparated, and the remaining liquor being evaporated nearly

nearly to drynefs, was again diluted with a mixture of water and alcohol. Another portion of fulphate of lime fell down, which being feparated, was added to the former. The whole of the fulphate of lime was decompofed by boiling it with carbonate of foda in folution, and the carbonate of lime thus obtained, after being wafhed and dried, weighed 17 grains, indicating nine grains and a half of pure lime.

K. Upon the fluid left from the laft procefs, cauftic foda was affufed; a flimy precipitate was formed, which rapidly diffolved in fulphuric acid, and communicated a brown colour to the folution. It was evaporated in a fand bath; loofe brown flakes fell down at the commencement of the procefs, and thefe being feparated by the filter, appeared to be oxide of manganefe; the quantity eftimated did not exceed one-eighth of a grain.

L. The remaining portion of the fluid was evaporated to drynefs, and the refiduum was expofed in a fmall crucible to a ftrong red heat. It was again diffolved in water, and yielded a fmall portion of alumina coloured with iron, and contaminated with manganefe. After ignition it did not weigh more than half a grain; but the clear folution was entirely cryftallized, and afforded fulphate of magnefia. Carbonate of foda was added to the magnefian falt in folution, by which the earthy bafe was precipitated in the ftate of carbonate. It weighed fix grains, which is equal to $2\frac{1}{4}$ grains of pure magnefia.

The following is the refult of the preceding analyfis.

Silica F	44.5 grs.
Alumina G	16.25
——— I	.5
Oxide of iron H	20.
Lime I	9.5
Magnefia L	2.25
Oxide of manganefe K	.12
Soda E	2.60
Water A	2.
	97.72

4. Magnesian Genus.

Befides feveral of the earths detected in minerals belonging to the former genera, the ftones arranged under this genus are diftinguifhed by being combined with magnefia. We fhall only give one example of the analyfis of a magnefian ftone.

Analysis of Steatites.

This mineral, which was found in Cornwall, was analyzed by Klaproth in the following manner.

A. One ounce of the ftone in fmall pieces was fubjected to a ftrong red heat, by placing the glafs retort which contained it in an open fire. A fmall portion of water diftilled over, which was pure and taftelefs. The mineral loft 75 grains of its weight, and became darker in the colour, and confiderably harder.

B. After being reduced to powder, it was carefully mixed, and heated red hot, with two ounces of carbonate of potafh in a porcelain pot. The concreted mafs was levigated with water, and digefted with muriatic acid in excefs. A white loofe flimy earth was precipitated, which after being wafhed, dried, and fubjected to a red heat, weighed 204 grains. It was pure filica.

C. Pruffiate of potafh was added to the filtered folution, and produced a blue precipitate, which being collected, wafhed, dried, and ignited with a little wax, was found, after cooling, to weigh feven grains. The whole of it was attracted by the magnet. The portion of iron belonging to the pruffiate of potafh being fubtracted, left $3\frac{3}{4}$ grains of oxide of iron as a conftituent of the mineral under examination.

D. Carbonate of potafh being added to the folution freed from the iron, precipitated its earthy ingredient. This, after wafhing, and gentle ignition, weighed 192 grains. Thefe were covered with a proportionate quantity of concentrated diftilled vinegar, and being digefted in a low heat, were thrown upon the filter. The earth remaining on the paper, which, after being dried and heated red hot, weighed 93 grains, was mixed with three times its weight of ftrong fulphuric acid, and the mixture being evaporated in a fand heat nearly to drynefs, the dry mafs was diffolved in water and filtered; 26 grains of filiceous earth were thus obtained.

E. In the fulphuric folution D, there ftill remained 67 grains of earth, which being precipitated by an alkali, appeared to confift entirely of aluminous earth.

F. Ninety-nine grains of the firft, 192 grains of the earthy precipitate D, were taken up by the acetic acid, which being precipitated by carbonate of potafh, and the earth obtained being tried by fulphuric acid, was found to be pure magnefia.

This analyfis fhows that the 480 grains of fteatites thus examined, afforded

Silica B	204
—— D	26
Magnefia F	99
Alumina E	67
Oxide of iron C	3.75
Water A	75.
	474.75
Lofs	5.25
	480.00

or 100 parts of the mineral contain

Silica	48
Magnefia	20.5
Alumina	14.
Oxide of iron	1.
Water	15.5
	99.0

5. Calcareous Genus.

The analyfis of ftones belonging to this genus muft be varied according to the nature of the combination into which the lime has entered. With regard to the proceffes to be followed in the examination of calcareous ftones, they are fufceptible of a natural divifion into fuch as are foluble in muriatic or nitric acid with effervefcence, and fuch as are fcarcely foluble in thofe acids, and do not effervefce. To the firft belong all the ftones called limeftones, or carbonates of lime; and to the fecond belongs fulphate of lime, or gypfum.

Analysis of Carbonate of Lime.

Carbonate of lime, whether in the form of lime fpar, or in a lefs pure ftate, in the form of limeftone, is foluble with

Calcareous Genus

with effervescence in nitric or muriatic acid. When exposed to heat, it yields carbonic acid gas, and is converted into quicklime; and when fused with an alkali, does not form a uniform mass. But we shall give a short view of the processes to be followed in a more particular examination.

A. Let a determinate quantity of the stone be reduced to a fine powder. Digest it repeatedly with muriatic acid till no further action is produced upon it. Dilute the solution, throw it upon a filter, and, after drying, weigh the insoluble residuum.

B. Let the remaining solution be diluted with 24 times its bulk of water; add sulphuric acid diluted; a precipitate takes place if the stone contained any barytes, the amount of which, after being collected and dried, may be ascertained by weighing.

C. Add to the filtered solution, after the barytes has been separated, a solution of carbonate of soda, as long as any precipitate is formed. Collect this precipitate, and let it be so much dried that it may be easily removed from the filter.

D. Affuse the precipitate with sulphuric acid till all effervescence ceases.

E. Introduce the whole into a mixture of three parts of distilled water, and one of alcohol, in the proportion of eight parts of the mixture to the quantity of the substance previously dissolved in nitric acid. Let the whole be digested for some hours in the cold, filter the fluid, and dry the insoluble residuum and weigh it.

F. The remaining solution is next to be decomposed by a solution of carbonate of potash, and the precipitate being collected, is to be washed, dried, and weighed.

By this examination, if the stone is to be ranked with carbonate of lime, the weight of the insoluble part E, after subtracting from it one-third, must exceed the weight of the insoluble parts A and B.

Analysis of Sulphate of Lime.

As this is insoluble in nitric or muriatic acids, its analysis must be conducted in a different manner.

A. Let one part of the mineral, reduced to fine powder, be boiled with four times its weight of carbonate of potash, in a sufficient quantity of water for two or three hours; as the fluid evaporates, water is to be added.

B. Introduce the insoluble mass obtained by the last process into a flask containing diluted nitric acid, and the whole being dissolved, let it be evaporated to dryness, and weighed.

C. Add to the dried mass more than its own weight of strong sulphuric acid; apply heat, and let it be gradually increased till fumes cease to rise, and let it be again weighed.

D. Let the insoluble part be digested in twice its weight of cold water; filter the fluid, collect the insoluble residuum, and dry it in a dull red heat. To ascertain the quantity of lime, subtract from the weight of the insoluble mass left (in C) 59 parts; what remains is equal to the quantity of lime.

E. The quantity of lime also may be ascertained, by subjecting for some hours to a red heat, the insoluble mass B; for by this process it will be converted into quicklime.

Analysis of Fluate of Lime.

In the examination of this mineral, a quantity of it may be reduced to powder, and moistened with sulphuric acid, in a leaden or pewter vessel. The mixture being heated, fumes arise, to which a plate of glass being exposed, is soon corroded. In this way the fluoric acid may be detected, and the quantity of base may be ascertained by decomposing the mineral by means of sulphuric acid, and afterwards analysing the sulphate of lime, as already directed.

Analysis of Phosphate of Lime.

The analysis of this mineral may be conducted in the following manner.

A. Let a determinate portion be digested in five times its quantity of muriatic acid, and let the operation be repeated till the acid has no farther action upon the residuum; decant the fluid, and then let it be diluted with water and filtered.

B. Add to the muriatic solution, liquid ammonia; collect the precipitate which is formed, and after being washed and dried, expose it to heat.

C. Add nitric acid to the precipitate till the whole is dissolved. Precipitate again by means of sulphuric acid; let the whole then be filtered, and let the insoluble residuum be washed with as little water as possible.

D. Evaporate the filtered fluid to the consistence of syrup; the fluid thus obtained is phosphoric acid, if the stone examined have been phosphate of lime. The test of phosphoric acid is, that it precipitates lime water, and also forms precipitates with the solutions of sulphate of iron, and nitrate of mercury; but it does not precipitate the muriate or nitrate of barytes.

6. Barytic Genus.

Analysis of Carbonate of Barytes.

A. Take a determinate quantity of the mineral, and dissolve it in diluted nitric acid; take a portion of the solution, and add to it a solution of sulphate of soda. If a precipitate take place, by adding a small quantity of the salt to the solution of the earth, diluted with 24 times its bulk of water, it may be inferred that the base of the mineral is barytes.

B. Let the nitric solution be evaporated to dryness, and exposed in a silver crucible to a white heat; the earth obtained is barytes, which is soluble in 20 times its weight of water; and after evaporation, crystallizes into long four-sided prisms.

Analysis of Sulphate of Barytes.

This mineral was analyzed by Klaproth in the following manner.

A. 200 grains were mixed with 500 grains of carbonate of potash, and were exposed for two hours to a red heat; the mass was reduced to powder, boiled with water, and the undissolved earth was collected on the filter.

B. To separate the siliceous earth, the fluid was neutralised by muriatic acid, and evaporated to dryness. The saline mass was redissolved in water, and the silica remaining after being ignited, weighed 18 grains.

C. The barytic earth, freed from the sulphuric acid B, was covered with water; muriatic acid was added; the whole was dissolved by digestion, except two grains of silica. The filtered solution was crystallized, and afforded muriate of barytes.

D. The crystals were redissolved in water, and sulphuric acid was added to the solution, while any precipitate appeared, and the regenerated sulphate of barytes being

Barytic Genus.

being washed and dried, weighed 185 grains, but after ignition, only 180 grains.

One hundred parts of this mineral are therefore composed of

Sulphate of barytes D	90
Silica B	9
—— C	1
	100 *

* Essays, i. 375.

7. Strontian Genus.

Analysis of Carbonate of Strontites.

This mineral was analyzed by Klaproth, in the following manner.

A. 100 parts were dissolved in muriatic acid, diluted with half its quantity of water. Thirty parts of carbonic acid were driven off during the solution, which being evaporated, afforded crystals in the shape of needles; and these crystals being dissolved in alcohol, communicated to it the property of burning with a carmine red flame. This is the test of strontitic earth.

B. To ascertain whether the mineral examined contained any barytes, three drops of a solution of one grain of sulphate of potash in six ounces of water were added to the muriatic solution; no appearance of precipitate was observed till next day, and therefore it contained no barytes, as in that case an immediate precipitate would have taken place.

C. Carbonate of potash was then added to the muriatic solution; a decomposition took place; and the carbonate of strontites was precipitated. This being subjected to a strong heat, the carbonic acid was driven off, and the whole of the remaining earth being dissolved in water, crystallized. After being dried, it weighed 69.5.

One hundred parts of this mineral therefore contain

Pure earth	69.5
Carbonic acid	30.
Water	.5
	100.0 †

† Ibid. i. 231.

II. Salts.

The analysis of minerals arranged under this class, is in general less difficult, in consequence of their easy solubility, than those already examined. We shall therefore give only one example.

Analysis of Native Saltpetre.

This native salt was examined by Klaproth ‡, according to the following method.

‡ Ibid. i. 270.

A. 1000 grains of the native salt, with limestone and gypsum to which it adhered, were covered with boiling water. The colourless solution was gently evaporated; during the crystallization, tender needle-shaped crystals of selenite appeared, and the whole of the solution crystallized to a perfect prismatic nitre. The selenite weighed 40 grains, and the salt amounted to 446 grains.

B. To ascertain whether any common salt could be detected in the mineral, the crystals were redissolved in water, and acetate of barytes was dropt into the solution. A precipitate was obtained, amounting to 26 grains of sulphate of barytes, shewing that 18½ grains of selenite were still combined with the neutral salt. A solution of nitrate of silver was added to the nitric solution, which produced a precipitate of 4½ grains of muriate of silver, so that the quantity of common salt can only be estimated at two grains. The pure nitre is thus reduced to 425½ grains. Klaproth suspects that the neutral muriate mixed with the native nitre, is rather a muriate of potash, than muriate of soda.

Salts.

C. The stony matters remaining amounted to 500 grains; muriatic acid was poured upon them, and produced great effervescence with pieces of limestone. One hundred and eighty-six grains of white gypsum remained; and the sulphuric acid being separated from it, by boiling with carbonate of potash, the carbonate of lime remaining behind dissolved without residuum in nitric acid.

D. The limestone taken up by the muriatic acid, weighed 304 grains. Being farther examined, it appeared to be calcareous earth, slightly contaminated with iron.

One hundred parts, therefore, of this salt contain

Pure prismatic nitre B	42.55
Muriate of a neutral salt B	.20
Sulphate of lime A B C	25.45
Carbonate of lime D	30.4
Loss	1.4
	100.00

III. Combustibles.

Analysis of Coal.

The constituent parts of coal are carbone and bitumen, with some earthy matters, and sometimes a small quantity of metallic matter. The proportion of earthy matters contained in coal may be ascertained by weighing a determinate quantity, and burning it. The nature of the earths contained in the residuum may be discovered by the processes already given.

To ascertain the proportion of charcoal and bitumen contained in coal, we shall describe the method followed by Mr Kirwan.

It has been found that a certain proportion of carbone or pure charcoal, detonated with nitre in the state of ignition, decomposes a given proportion of that salt; and it appears from the experiments of Lavoisier, that 13.21 parts of charcoal decompose 100 parts of nitre, while the detonation is performed in close vessels; but in an open crucible, a smaller proportion of charcoal is required, in consequence of part of the nitre being decomposed by the action of the air of the atmosphere. According to Kirwan, about 10 parts of charcoal are sufficient to decompose 96 parts of nitre. Mr Kirwan also found that vegetable pitch and maltha did not produce any detonation with nitre, but merely burnt on its surface; and that the same quantity of charcoal was required for the decomposition of the nitre, as if no bituminous substance had been employed. Since, therefore, bitumen produces no effect in decomposing nitre, Kirwan thought that the proportion of charcoal, in any coal, might be ascertained by detonation with nitre. In this way the proportion of carbonaceous and earthy matter in any coal being discovered, the proportion of bitumen which it contains may be estimated by calculation.

In the experiments on the analysis of coal, Mr Kirwan employed a large crucible placed in a wind furnace, and exposed to an equable heat. The coal was reduced to small

Combustibles.

small pieces of the size of a pin head, and was projected in portions of one or two grains at a time, into the nitre, the moment it became red hot. This was continued till the detonation ceased.

By this process it appeared that 50 grains of Kilkenny coal were necessary to decompose 480 grains of nitre. According to the same proportion, 96 grains of nitre would have required for its decomposition 10 grains of coal, which is exactly equal to the quantity of charcoal that would have been required to produce the same effect; and thus it appeared that Kilkenny coal is almost entirely composed of carbonaceous matter.

In the examination of cannel coal, Mr Kirwan burnt 240 grains, till the whole of the carbonaceous matter was consumed; a residuum of seven grains and a half of reddish brown ashes, which appeared to be chiefly aluminous earth, was left, or about 3.12 per cent. Sixty-six grains and a half of this coal were found necessary to decompose 480 grains of nitre. Fifty grains of charcoal would have produced the same effect, and hence $66\frac{1}{2}$ grains of coal contain 50 of charcoal, and 2.08 parts of ashes, which being subtracted from $66\frac{1}{2}$ grains, leaves 14.42 for the quantity of bitumen contained in the coal. Hence the constituent parts of this coal are,

Charcoal	75.2
Bitumen	21.68
Ashes	3.1
	99.98

For a more particular analysis of combustible minerals, see Mr Hatchett's experiments, detailed in the Philosophical Transactions for 1804.

IV. *Analysis of* Soils.

The examination of soils is by no means the least important, because on a knowledge of the nature and proportions of the ingredients which enter into the composition of soils, depends the opinion to be formed of their fertility. Soils consist of different combinations of the earths, mixed with a certain proportion of animal and vegetable matter. The investigation of the nature of soils has been particularly prosecuted by Mr Kirwan * and Mr Davy. From the observations of the latter, the following account of the analysis of soils is extracted.

* See his *Treatise on Manures.*

1 Instruments for the analysis of soils.

1. The really important instruments required for the analysis of soils are few, and but little expensive. They are, a balance capable of containing a quarter of a pound of common soil, and capable of turning when loaded with a grain; and a series of weights from a quarter of a pound troy to a grain; a wire sieve, sufficiently coarse to admit a pepper-corn through its apertures; an Argand lamp and stand; some glass bottles; Hessian crucibles; porcelain or queen's ware evaporating basons; a Wedgewood pestle and mortar; some filters made of half a sheet of blotting paper, folded so as to contain a pint of liquid, and greased at the edges; a bone knife, and an apparatus for collecting and measuring aëriform fluids.

The chemical substances or reagents required for separating the constituent parts of the soil, are muriatic acid (spirit of salt), sulphuric acid, and pure volatile alkali dissolved in water, solution of prussiate of potash, soap lye, solution of carbonate of ammonia, of muriate of ammonia, solution of neutral carbonate of potash, and nitrate of ammonia.

Soils.

2 Mode of collecting soils for analysis.

2. In cases when the general nature of the soil of a field is to be ascertained, specimens of it should be taken from different places, two or three inches below the surface, and examined as to the similarity of their properties. It sometimes happens, that upon plains the whole of the upper stratum of the land is of the same kind, and in this case one analysis will be sufficient; but in valleys, and near the beds of rivers, there are very great differences, and it now and then occurs that one part of a field is calcareous, and another part siliceous; and in this case, and in analogous cases, the portions different from each other should be separately submitted to experiment.

Soils, when collected, if they cannot be immediately examined, should be preserved in phials quite filled with them, and closed with ground glass stoppers.

The quantity of soil most convenient for a perfect analysis is from two to four hundred grains. It should be collected in dry weather, and exposed to the atmosphere till it becomes dry to the touch.

The specific gravity of a soil, or the relation of its weight to that of water, may be ascertained by introducing into a phial, which will contain a known quantity of water, equal volumes of water and of soil; and this may be easily done by pouring in water till it is half full, and then adding the soil till the fluid rises to the mouth; the difference between the weight of the soil and that of the water will give the result. Thus, if the bottle contain 400 grains of water, and gains 200 grains when half filled with water and half with soil, the specific gravity of the soil will be two, that is, it will be twice as heavy as water; and if it gained 165 grains, its specific gravity would be 1825, water being 1000.

It is of importance that the specific gravity of a soil should be known, as it affords an indication of the quantity of animal and vegetable matter it contains; these substances being always most abundant in the lighter soils.

The other physical properties of soils should likewise be examined before the analysis is made, as they denote, to a certain extent, their composition, and serve as guides in directing the experiments. Thus, siliceous soils are generally rough to the touch, and scratch glass when rubbed upon it; aluminous soils adhere strongly to the tongue, and emit a strong earthy smell when breathed on; and calcareous soils are soft, and much less adhesive than aluminous soils.

3 Mode of ascertaining the quantity of water absorbed by soils.

3. Soils, though as dry as they can be made by continued exposure to air, in all cases still contain a considerable quantity of water, which adheres with great obstinacy to the earths and animal and vegetable matter, and can only be driven off from them by a considerable degree of heat. The first process of analysis is, to free the given weight of the soil from as much of this water as possible, without, in other respects, affecting its composition; and this may be done by heating it for ten or twelve minutes over an Argand's lamp, in a bason of porcelain, to a temperature equal to 300 Fahrenheit; and in case a thermometer is not used, the proper degree may be easily ascertained, by keeping a piece of wood in contact with the bottom of the dish: as long as the colour of the wood remains unaltered, the heat is not too high; but when the wood begins to be charred, the process must be stopped. A small quantity of water will perhaps remain in the soil even after this operation, but

but it always affords ufeful comparative refults; and if a higher temperature were employed, the vegetable or animal matter would undergo decompofition, and in confequence the experiment be wholly unfatisfactory.

The lofs of weight in the procefs fhould be carefully noted; and when in 400 grains of foil it reaches as high as 50, the foil may be confidered as in the greateft degree abforbent, and retentive of water, and will generally be found to contain a large proportion of aluminous earth. When the lofs is only from 20 to 10, the land may be confidered as only flightly abforbent and retentive, and the filiceous earth as moft abundant.

4 Separation of ftones, &c.

4. None of the loofe ftones, gravel, or large vegetable fibres fhould be divided from the pure foil till after the water is drawn off; for thefe bodies are themfelves often highly abforbent and retentive, and in confequence influence the fertility of the land. The next procefs, however, after that of heating, fhould be their feparation, which may be eafily accomplifhed by the fieve, after the foil has been gently bruifed in a mortar. The weights of the vegetable fibres or wood, and of the gravel and ftones, fhould be feparately noted down, and the nature of the laft afcertained: if calcareous, they will effervefce with acids; if filiceous, they will be fufficiently hard to fcratch glafs; and if of the common aluminous clafs of ftones, they will be foft, eafily fcratched with a knife, and incapable of effervefcing with acids.

5 Separation of the fand and clay, or loam, from each other.

5. The greater number of foils, befides gravel and ftones, contain larger or fmaller proportions of fand of different degrees of finenefs; and it is a neceffary operation, the next in the procefs of analyfis, to detach them from the parts in a ftate of more minute divifion, fuch as clay, loam, marle, and vegetable and animal matter. This may be effected in a way fufficiently accurate, by agitation of the foil in water. In this cafe, the coarfe fand will generally feparate in a minute, and the finer in two or three minutes; whilft the minutely divided animal or vegetable matter will remain in a ftate of mechanical fufpenfion for a much longer time; fo that, by pouring the water from the bottom of the veffel, after one, two, or three minutes, the fand will be principally feparated from the other fubftances, which, with the water containing them, muft be poured into a filter, and, after the water has paffed through, collected, dried, and weighed. The fand muft likewife be weighed, and their refpective quantities noted down. The water of lixiviation muft be preferved, as it will be found to contain the faline matter, and the foluble animal or vegetable matters, if any exift in the foil.

6 Examination of the fand.

6. By the procefs of wafhing and filtration, the foil is feparated into two portions, the moft important of which is generally the finely divided matter. A minute analyfis of the fand is feldom or never neceffary, and its nature may be detected in the fame manner as that of the ftones or gravel. It is always either filiceous fand, or calcareous fand, or a mixture of both. If it confift wholly of carbonate of lime, it will be rapidly foluble in muriatic acid, with effervefcence; but if it confift partly of this fubftance, and partly of filiceous matter, the refpective quantities may be afcertained by weighing the refiduum after the action of the acid, which muft be applied till the mixture has acquired a four tafte, and has ceafed to effervefce. This refiduum is the filiceous part; it muft be wafhed, dried, and heated ftrongly in a crucible: the difference between the weight of the whole, indicates the proportion of calcareous fand.

7 Examination of the finely divided matter of foils, and mode of detecting mild lime and magnefia.

7. The finely divided matter of the foil is ufually very compound in its nature; it fometimes contains all the four primitive earths of foils, as well as animal and vegetable matter; and to afcertain the proportions of thefe with tolerable accuracy, is the moft difficult part of the fubject.

The first procefs to be performed, in this part of the analyfis, is the expofure of the fine matter of the foil to the action of the muriatic acid. This fubftance fhould be poured upon the earthy matter in an evaporating bafon, in a quantity equal to twice the weight of the earthy matter; but diluted with double its volume of water. The mixture fhould be often ftirred, and fuffered to remain for an hour or an hour and a half before it is examined.

If any carbonate of lime or of magnefia exift in the foil, they will have been diffolved in this time by the acid, which fometimes takes up likewife a little oxide of iron; but very feldom any alumina.

The fluid fhould be paffed through a filter; the folid matter collected, wafhed with rain water, dried at a moderate heat, and weighed. Its lofs will denote the quantity of folid matter taken up. The wafhings muft be added to the folution; which, if not four to the tafte, muft be made fo by the addition of frefh acid, when a little folution of common pruffiate of potafh muft be mixed with the whole. If a blue precipitate occur, it denotes the prefence of oxide of iron, and the folution of the pruffiate muft be dropped in till no further effect is produced. To afcertain its quantity, it muft be collected in the fame manner as other folid precipitates, and heated: the refult is oxide of iron.

Into the fluid freed from oxide of iron, a folution of neutralized carbonate of potafh muft be poured till all effervefcence ceafes in it, and till its tafte and fmell indicate a confiderable excefs of alkaline falt.

The precipitate that falls down is carbonate of lime; it muft be collected on the filter, and dried at a heat below that of rednefs.

The remaining fluid muft be boiled for a quarter of an hour, when the magnefia, if any exift, will be precipitated from it, combined with carbonic acid, and its quantity is to be afcertained in the fame manner as that of the carbonate of lime.

If any minute proportion of alumina fhould, from peculiar circumftances, be diffolved by the acid, it will be found in the precipitate with the carbonate of lime, and it may be feparated from it by boiling for a few minutes with foap lye, fufficient to cover the folid matter. This fubftance diffolves alumina, without acting upon carbonate of lime.

Should the finely divided foil be fufficiently calcareous to effervefce very ftrongly with acids, a very fimple method may be adopted for afcertaining the quantity of carbonate of lime, and one fufficiently accurate in all common cafes.

Carbonate of lime, in all its ftates, contains a determinate proportion of carbonic acid, *i. e.* about 45 per cent.; fo that when the quantity of this elaftic fluid, given out by any foil during the folution of its calcareous matter in an acid, is known, either in weight or meafure, the quantity of carbonate of lime may be eafily difcovered.

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When the proceſs by diminution of weight is employed, two parts of the acid and one part of the matter of the ſoil muſt be weighed in two ſeparate bottles, and very ſlowly mixed together till the effervefcence ceaſes; the difference between their weight before and after the experiment denotes the quantity of carbonic acid loſt; for every four grains and a half of which, ten grains of carbonate of lime muſt be eſtimated.

The beſt method of collecting the carbonic acid, ſo as to diſcover its volume, is by the pneumatic apparatus, the conſtruction and application of which are deſcribed at the end of this article. The eſtimation is, for every ounce meaſure of carbonic acid, two grains of carbonate of lime.

8 Mode of aſcertaining the quantity of inſoluble finely divided animal and vegetable matter.

8. After the fine matter of the ſoil has been acted upon by muriatic acid, the next proceſs is to aſcertain the quantity of finely divided inſoluble animal and vegetable matter that it contains.

This may be done with ſufficient preciſion, by heating it to ſtrong ignition in a crucible over a common fire till no blackneſs remains in the maſs. It ſhould be often ſtirred with a metallic wire, ſo as to expoſe new ſurfaces continually to the air; the loſs of weight that it undergoes denotes the quantity of the ſubſtance that it contains deſtructible by fire and air.

It is not poſſible to aſcertain whether this ſubſtance is wholly animal or vegetable matter, or a mixture of both. When the ſmell emitted during the incineration is ſimilar to that of burnt feathers, it is a certain indication of ſome animal matter; and a copious blue flame at the time of ignition almoſt always denotes a conſiderable proportion of vegetable matter. In caſes when the experiment is needed to be very quickly performed, the deſtruction of the decompoſable ſubſtances may be aſſiſted by the agency of nitrate of ammonia, which, at the time of ignition, may be thrown gradually upon the heated maſs, in the quantity of twenty grains for every hundred of reſidual oil. It affords the principle neceſſary to the combuſtion of the animal and vegetable matter, which it cauſes to be converted into elaſtic fluids; and it is itſelf at the ſame time decompoſed and loſt.

9 Mode of ſeparating aluminous and ſiliceous matter and oxide of iron.

9. The ſubſtances remaining after the decompoſition of the vegetable and animal matter, are generally minute particles of earthy matter containing uſually alumina and ſilica with combined oxide of iron.

To ſeparate theſe from each other, the ſolid matter ſhould be boiled for two or three hours with ſulphuric acid, diluted with four times its weight of water; the quantity of the acid ſhould be regulated by the quantity of ſolid reſiduum to be acted on, allowing for every hundred grains two drachms or one hundred and twenty grains of acid.

The ſubſtance remaining after the action of the acid may be conſidered as ſiliceous; and it muſt be ſeparated and its weight aſcertained, after waſhing and drying in the uſual manner.

The alumina and the oxide of iron, if they exiſt, are both diſſolved by the ſulphuric acid; they may be ſeparated by carbonate of ammonia, added to exceſs; it throws down the alumina, and leaves the oxide of iron in ſolution; and this ſubſtance may be ſeparated from the liquid by boiling.

Should any magneſia and lime have eſcaped ſolution in the muriatic acid, they will be found in the ſulphuric acid; this, however, is ſcarcely ever the caſe; but the proceſs for detecting them, and aſcertaining their quantities, is the ſame in both inſtances.

The method of analyſis by ſulphuric acid is ſufficiently preciſe for all uſual experiments; but if very great accuracy be an object, dry carbonate of potaſh muſt be employed as the agent, and the reſiduum of the incineration muſt be heated red for half an hour, with four times its weight of this ſubſtance, in a crucible of ſilver, or of well baked porcelain. The maſs obtained muſt be diſſolved in muriatic acid, and the ſolution evaporated till it is nearly ſolid; diſtilled water muſt then be added, by which the oxide of iron and all the earths, except ſilica, will be diſſolved in combination as muriates. The ſilex, after the uſual proceſs of lixiviation, muſt be heated red; the other ſubſtances may be ſeparated in the ſame manner as from the muriatic and ſulphuric ſolutions.

10 Mode of diſcovering ſoluble animal and vegetable matter, and ſaline matter.

10. If any ſaline matter, or ſoluble vegetable or animal matter, be ſuſpected in the ſoil, it will be found in the water of lixiviation uſed for ſeparating the ſand.

This water muſt be evaporated to dryneſs in an appropriate diſh, at a heat below its boiling point.

If the ſolid matter obtained is of a brown colour and inflammable, it may be conſidered as partly vegetable extract. If its ſmell, when expoſed to heat, be ſtrong and fœtid, it contains animal mucilaginous or gelatinous ſubſtance; if it be white and tranſparent, it may be conſidered as principally ſaline matter. Nitrate of potaſh (nitre), or nitrate of lime, is indicated in this ſaline matter, by its detonating with a burning coal. Sulphate of magneſia may be detected by its bitter taſte; and ſulphate of potaſh produces no alteration in ſolution of carbonate of ammonia, but precipitates ſolution of muriate of barytes.

11 Mode of detecting ſulphate of lime (gypſum) and phoſphate of lime in ſoils.

11. Should ſulphate or phoſphate of lime be ſuſpected in the entire ſoil, the detection of them requires a particular proceſs upon it. A given weight of it, for inſtance four hundred grains, muſt be heated red for half an hour in a crucible, mixed with one third of powdered charcoal. The mixture muſt be boiled for a quarter of an hour, in a half-pint of water, and the fluid collected through the filter, and expoſed for ſome days to the atmoſphere in an open veſſel. If any ſoluble quantity of ſulphate of lime (gypſum) exiſted in the ſoil, a white precipitate will gradually form in the fluid, and the weight of it will indicate the proportion.

Phoſphate of lime, if any exiſt, may be ſeparated from the ſoil after the proceſs for gypſum. Muriatic acid muſt be digeſted upon the ſoil, in quantity more than ſufficient to ſaturate the ſoluble earths; the ſolution muſt be evaporated, and water poured upon the ſolid matter. This fluid will diſſolve the compounds of earths with the muriatic acid, and leave the phoſphate of lime untouched.

12 Reſults and products.

12. When the examination of a ſoil is completed, the products ſhould be claſſed, and their quantities added together; and if they nearly equal the original quantity of ſoil, the analyſis may be conſidered as accurate. It muſt however be noticed, that when phoſphate or ſulphate of lime is diſcovered by the independent proceſs 11. a correction muſt be made for the general proceſs, by ſubtracting a ſum equal to their weight from the quantity of carbonate of lime obtained by precipitation from the muriatic acid.

In arranging the products, the form ſhould be in the order

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order of the experiments by which they were obtained.

Thus, 400 grains of a good siliceous sandy soil may be supposed to contain

Of water of absorption - -	18 grs.
Of loose stones and gravel, principally siliceous, - -	42
Of undecompounded vegetable fibres	10
Of fine siliceous sand - -	200
Of minutely divided matter separated by filtration, and consisting of	
Carbonate of lime - -	25
Carbonate of magnesia - -	4
Matter destructible by heat, principally vegetable, - -	10
Silica - - - - - -	40
Alumina - - - - -	32
Oxide of iron - - - -	4
Soluble matter, principally sulphate of potash and vegetable extract, - -	5
Gypsum - - - - -	3
Phosphate of lime - -	2
Amount of all the products	395
Loss - - - -	5

In this instance the loss is supposed small; but in general, in actual experiments, it will be found much greater, in consequence of the difficulty of collecting the whole quantities of the different precipitates; and when it is within thirty for four hundred grains, there is no reason to suspect any want of due precision in the processes.

13 Chemical composition of fertile corn soils in this climate.

13. A very fertile corn soil from Ormiston in East Lothian afforded, in 100 parts, only 11 parts of mild calcareous earth; it contained 25 parts of siliceous sand: the finely divided clay amounted to 45 parts. It lost nine in decomposed animal and vegetable matter, and four in water, and afforded indications of a small quantity of phosphate of lime.

This soil was of a very fine texture, and contained very few stones or vegetable fibres. It is not unlikely that its fertility was in some measure connected with the phosphate; for this substance is found in wheat, oats, and barley, and may be a part of their food.

A soil from the low lands of Somersetshire, celebrated for producing excellent crops of wheat and beans without manure, was found to consist of one-ninth of sand, chiefly siliceous, and eight-ninths of calcareous marl tinged with iron, and containing about five parts in 100 of vegetable matter. No phosphate or sulphate of lime could be detected in it; so that its fertility must have depended principally upon its power of attracting principles of vegetable nourishment from water and the atmosphere.

14 Composition of soils proper for bulbous roots and for trees.

Mr Tillet, in some experiments made on the composition of soils at Paris, found that a soil composed of three-eighths of clay, two-eighths of river sand, and three-eighths of the parings of limestone, was very proper for wheat.

14. In general, bulbous roots require a soil much more sandy and less absorbent than the grasses. A very good potato soil, from Varsel in Cornwall, afforded seven-eighths of siliceous sand; and its absorbent power was so small, that 100 parts lost only two by drying at 400 Fahrenheit.

Plants and trees, the roots of which are fibrous and hard, and capable of penetrating deep into the earth, will vegetate to advantage in almost all common soils which are moderately dry, and which do not contain a very great excess of vegetable matter.

The soil taken from a field at Sheffield-place in Sussex, remarkable for producing flourishing oaks, was found to consist of six parts of sand, and one part of clay and finely divided matter. And 100 parts of the entire soil, submitted to analysis, produced

Water - -	3 parts
Silica - - -	54
Alumina - - - -	28
Carbonate of lime - -	3
Oxide of iron - -	5
Decomposing vegetable matter	4
Loss - - -	3

15 Improvements made by changing the composition of the earthy parts of soils.

15. From the great difference of the causes that influence the productiveness of lands, it is obvious that, in the present state of science, no certain system can be devised for their improvement, independent of experiment: but there are few cases in which the labour of analytical trials will not be amply repaid by the certainty with which they denote the best methods of amelioration; and this will particularly happen when the defect of composition is found in the proportions of the primitive earths.

In supplying animal or vegetable manure, a temporary food only is provided for plants, which is in all cases exhausted by means of a certain number of crops; but when a soil is rendered of the best possible constitution and texture, with regard to its earthy parts, its fertility may be considered as permanently established. It becomes capable of attracting a very large portion of vegetable nourishment from the atmosphere, and of producing its crops with comparatively little labour and expence.

Description of the Apparatus for the Analysis of Soils. Plate DIX.

A, Retort.

B, B, Funnels for the purpose of filtrating.

D, Balance.

E, Argand's lamp.

F, G, H, K, The different parts of the apparatus required for measuring the quantity of elastic fluid given out during the action of an acid on calcareous soils.

F, Represents the bottle for containing the soil.

K, The bottle containing the acid furnished with a stopcock.

G, The tube connected with a flaccid bladder.

I, The graduated measure.

H, The bottle for containing the bladder. When this instrument is used, a given quantity of soil is introduced into F; K is filled with muriatic acid diluted with an equal quantity of water; and the stopcock being closed is connected with the upper orifice of F, which is ground to receive it. The tube G is introduced into the lower orifice of F, and the bladder connected with it placed in its flaccid state into H, which is filled with water. The graduated measure is placed under the tube of H. When the stopcock of K is turned,

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ed, the acid flows into F, and acts upon the soil; the elastic fluid generated passes through G into the bladder, and displaces a quantity of water in H equal to it in bulk, and this water flows through the tube into the graduated measure; the water in which gives by its volume the indication of the proportion of carbonic acid disengaged from the soil; for every ounce measure of which two grains of carbonate of lime may be estimated.

L, Represents the stand for the lamp.

M, N, O, P, Q, R, S, Represent the bottles containing the different reagents.*

* Phil. Mag. vol. xxiii. p. 26

Stones.

Artificial STONE. See STUCCO.

Elastic STONE. Some marbles possess the property of elasticity, and hence come under the denomination of elastic stones. But the most remarkable stone of this nature is the elastic sandstone from Brazils. It is a micaceous sandstone in laminæ not exceeding half an inch in thickness. Some siliceous stones also have the same property, or acquire it by being exposed to a certain degree of heat.

Philosopher's STONE. See PHILOSOPHER'S *Stone.*

Precious STONES. See GEM.

Rocking STONE, or *Logan*, a stone of a prodigious size, so exactly poised, that it would rock or shake with the smallest force. Of these stones the ancients give us some account. Pliny says, that at Harpasa, a town of Asia, there was a rock of such a wonderful nature, that if touched with the finger it would shake, but could not be moved from its place with the whole force of the body*. Ptolemy Hephestion mentions † a gygonian stone near the ocean, which was agitated when struck by the stalk of an asphodel, but could not be removed by a great exertion of force. The word *gygonius* seems to be Celtic; for *gwingog* signifies *motitans*, the rocking-stone.

* Lib. ii. c. 69.

† Lib. iii. c. 3.

Many rocking stones are to be found in different parts of this island; some natural, others artificial, or placed in their position by human art. In the parish of St Leven, Cornwall, there is a promontory called *Castle Treryn*. On the western side of the middle group, near the top, lies a very large stone, so evenly poised that any hand may move it from one side to another; yet it is so fixed on its base, that no lever nor any mechanical force can remove it from its present situation. It is called the *Logan-stone*, and is at such a height from the ground that no person can believe that it was raised to its present position by art. But there are other rocking stones, which are so shaped and so situated, that there can be no doubt but they were erected by human strength. Of this kind Borlase thinks the great *Quoit* or *Karn-lehau*, in the parish of Tywidnek, to be. It is 39 feet in circumference, and four feet thick at a medium, and stands on a single pedestal. There is also a remarkable stone of the same kind in the island of St Agnes in Scilly. The under rock is 10 feet six inches high, 47 feet round the middle, and touches the ground with no more than half its base. The upper rock rests on one point only, and is so nicely balanced, that two or three men with a pole can move it. It is eight feet six inches high, and 47 in circumference. On the top there is a bason hollowed out, three feet eleven inches in diameter at a medium, but wider at the brim, and three feet deep. From the globular shape of this upper stone, it is highly probable that it was rounded by human art, and perhaps even placed on its pedestal by human strength. In Sithney parish, near Helston, in Cornwall, stood the famous logan, or rocking stone, commonly called *Men Amber*, q. d. *Men an Bar*, or the *top-stone*. It was eleven feet by six, and four high, and so nicely poised on another stone that a little child could move it, and all travellers who came this way desired to see it. But Shrubsall, Cromwell's governor of Pendennis, with much ado caused it to be undermined, to the great grief of the country. There are some marks of the tool on it, and, by its quadrangular shape, it was probably dedicated to Mercury.

Borlase, chap. iv. p. 181.

That the rocking stones are monuments erected by the Druids cannot be doubted; but tradition has not informed us for what purpose they were intended. Mr Toland thinks that the Druids made the people believe that they alone could move them, and that by a miracle; and that by this pretended miracle they condemned or acquitted the accused, and brought criminals to confess what could not otherwise be extorted from them. How far this conjecture is right we shall leave to those who are deeply versed in the knowledge of antiquities to determine.

Sonorous STONE, a kind of stone remarkable for emitting an agreeable sound when struck, and much used in China for making musical instruments which they call *king*.

The various kinds of sonorous stones known in China differ considerably from one another in beauty, and in the strength and duration of their tone; and what is very surprising, is that this difference cannot be discovered either by the different degrees of their hardness, weight, or fineness of grain, or by any other qualities which might be supposed to determine it. Some stones are found remarkably hard, which are very sonorous; and others exceedingly soft, which have an excellent tone; some extremely heavy emit a very sweet sound; and there are others as light as pumice stone which have also an agreeable sound.

The chemists and naturalists of Europe have never yet attempted to discover, whether some of our stones may not have the same properties as the sonorous stones of the extremities of Asia. It however appears, that the Romans were formerly acquainted with a sonorous stone of the class of *hiang-che*. Pliny (says the Abbé du Bos, in his Reflections on Poetry and Painting, when speaking of curious stones) observes that the stone called *chalcophonas*, or *brazen sound*, is black; and that, according to the etymology of its name, it sends forth a sound much resembling that of brass when it is struck. The passage of Pliny is as follows: *Chalcophonas nigra est; sed elisa æris tinnitum reddit.*

Some sonorous stones were at length sent into France, and

Stone, Stonehenge.

and the late Duke de Chaulnes examined them with particular attention. The following are ſome of his obſervations: "The Academy of Sciences, Mr Romé de Liſle, and ſeveral other learned mineralogiſts, when aſked if they were acquainted with the black ſtone of which the Chineſe king was made, for anſwer cited the paſſage of Pliny mentioned by Boethius de Bott, Linnæus, and in the Dictionary of Bomare, and added what Mr Anderſon ſays in his Natural Hiſtory of Iceland reſpecting a bluiſh kind of ſtone which is very ſonorous. As the black ſtone of the Chineſe becomes of a bluiſh colour when filed, it is probably of the ſame ſpecies. None of the reſt who were conſulted had ever ſeen it. The Chineſe ſtone has a great reſemblance at firſt ſight to black marble, and like it is calcareous; but marble generally is not ſonorous. It alſo externally reſembles touchſtone, which is a kind of baſaltes, and the baſaltes found near volcanoes; but theſe two ſtones are vitrifications."

The duke next endeavoured to procure ſome information from the ſtone-cutters. They all replied, that blue-coloured marble was very ſonorous, and that they had ſeen large blocks of it which emitted a very ſtrong ſound; but the duke having ordered a king to be conſtructed of this kind of ſtone, it was found that it did not poſſeſs that property. By trying the black marble of Flanders, a piece was at length found which emitted an agreeable ſound: it was cut into a king, which is almoſt as ſonorous as thoſe of China. All theſe obſervations give us reaſon to believe that the ſtones of which the king are formed are nothing elſe but a black kind of marble, the conſtituent parts of which are the ſame as thoſe of the marble of Europe, but that ſome difference in their organization renders them more or leſs ſonorous.

Swine-STONE (lapis ſuillus), or *fetid ſtone*, ſo called from its exceſſively fetid ſmell, is a calcareous ſtone impregnated with petroleum. See MINERALOGY *Index*.

STONE-Marrow, a variety of clay ſo called from its having the appearance of marrow.

STONE-Ware, a ſpecies of pottery ſo called from its hardneſs. See *DELFT-Ware* and PORCELAIN.

STONE in the Bladder. See MEDICINE, N° 400, and SURGERY *Index*.

STONE, in merchandize, denotes a certain weight for weighing commodities. A ſtone of beef at London is the quantity of eight pounds: in Herefordſhire 12 pounds: in the North 16 pounds. A ſtone of glaſs is five pounds; of wax eight pounds. A ſtone of wool (according to the ſtatute of 11 Hen. VII.) is to weigh 14 pounds; yet in ſome places it is more, in others leſs; as in Glouceſterſhire 15 pounds; in Herefordſhire 12 pounds. Among horſe-courſers a ſtone is the weight of 14 pounds.

The reaſon of the name is evident. Weights at firſt were generally made of ſtone. See Deut. xxv. 13. where the word אבן, tranſlated *weight*, properly ſignifies a *ſtone*.

STONE-Chatter. See MOTACILLA, ORNITHOLOGY *Index*.

STONEHENGE, a celebrated monument of antiquity, ſtands in the middle of a flat area near the ſummit of a hill ſix miles diſtant from Saliſbury. It is incloſed by a circular double bank and ditch near 30 feet broad, after croſſing which we aſcend 30 yards before we reach the work. The whole fabric conſiſted of two circles and two ovals. The outer circle is about 108 feet diameter, conſiſting when entire of 60 ſtones, 30 uprights and 30 impoſts, of which remain only 24 uprights, 17 ſtanding and 7 down, 3½ feet aſunder, and 8 impoſts. Eleven uprights have their 5 impoſts on them by the grand entrance. Theſe ſtones are from 13 to 20 feet high. The leſſer circle is ſomewhat more than 8 feet from the inſide of the outer one, and conſiſted of 40 leſſer ſtones (the higheſt 6 feet), of which only 19 remain, and only 11 ſtanding: the walk between theſe two circles is 300 feet in circumference. The Adytum or Cell is an oval formed of 10 ſtones (from 16 to 22 feet high), in pairs, with impoſts, which Dr Stukeley calls *trilithons*, and above 30 feet high, riſing in height as they go round, and each pair ſeparate. and not connected as the outer pair; the higheſt 8 feet. Within theſe are 19 more ſmaller ſingle ſtones, of which only 6 are ſtanding. At the upper end of the Adytum is the altar, a large ſlab of blue coarſe marble, 20 inches thick, 16 feet long, and 4 broad; preſſed down by the weight of the vaſt ſtones that have fallen upon it. The whole number of ſtones, uprights, impoſts, and altar, is exactly 140. The ſtones are far from being artificial, but were moſt probably brought from thoſe called the *Grey Weathers* on Marlborough Downs, 15 or 16 miles off; and if tried with a tool they appear of the ſame hardneſs, grain, and colour, generally reddiſh. The heads of oxen, deer, and other beaſts, have been found on digging in and about Stonehenge; and human bones in the circumjacent barrows. There are three entrances from the plain to this ſtructure, the moſt conſiderable of which is from the north-eaſt, and at each of them were raiſed on the outſide of the trench two huge ſtones with two ſmaller within parallel to them.

Stonehenge. Gough's edition of Camden's Britannia, vol. i. p. 107.

It has been long a diſpute among the learned, by what nation, and for what purpoſe, theſe enormous ſtones were collected and arranged. The firſt account of this ſtructure we meet with is in Geoffroy of Monmouth, who, in the reign of King Stephen, wrote the hiſtory of the Britons in Latin. He tells us, that it was erected by the counſel of Merlin the Britiſh enchanter, at the command of Aurelius Ambroſius the laſt Britiſh king, in memory of 460 Britons who were murdered by Hengiſt the Saxon. The next account is that of Polydore Virgil, who ſays that the Britons erected this as a ſepulchral monument of Aurelius Ambroſius. Others ſuppoſe it to have been a ſepulchral monument of Boadicea the famous Britiſh queen. Inigo Jones is of opinion, that it was a Roman temple; from a ſtone 16 feet long, and four broad, placed in an exact poſition to the eaſtward altar-faſhion. Mr Charlton attributed it to the Danes, who were two years maſters of Wiltſhire. A tin tablet, on which were ſome unknown characters, ſuppoſed to be Punic, was digged up near it in the reign of Henry VIII. but is loſt; probably that might have given ſome information reſpecting its founders. Its common name, *Stonehenge*, is Saxon, and ſignifies a "ſtone gallows," to which thoſe ſtones, having tranſverſe impoſts, bear ſome reſemblance. It is alſo called in Welch *choir gour*, or "the giants dance."

Mr Groſe thinks that Dr Stukeley has completely proved this ſtructure to have been a Britiſh temple in which the Druids officiated. He ſuppoſes it to have been the metropolitan temple of Great Britain, and tranſlates

translates the words *choir gour* "the great choir or temple." The learned Mr Bryant is of opinion that it was erected by a colony of Cuthites probably before the time of the Druids; because it was usual with them to place one vast stone upon another for a religious memorial; and these they often placed so equably, that even a breath of wind would sometimes make them vibrate. Of such stones one remains at this day in the pile of Stonehenge. The ancients distinguished stones erected with a religious view, by the name of *amber;* by which was signified any thing solar and divine. The Grecians called them πετραι αμβροσιαι, *petræ ambrosiæ*. Stonehenge, according to Mr Bryant, is composed of these amber stones: hence the next town is denominated *Ambresbury;* not from a Roman Ambrosius, for no such person ever existed, but from the *ambrosiæ petræ*, in whose vicinity it stood. Some of these were rocking stones; and there was a wonderful monument of this sort near Penzance in Cornwall, which still retains the name of *main-amber*, or the sacred stones. Such a one is mentioned by Apollonius Rhodius, supposed to have been raised in the time of the Argonautæ, in the island Tenos, as the monument of the two-winged sons of Boreas, slain by Hercules; and there are others in China and other countries.

Grose's Antiquities, vol iv. p. 40.

STOOK, a term used in many parts of the kingdom for a shock of corn containing 12 sheaves.

STOOL, in *Medicine*, an evacuation or discharge of the fæces by the anus.

STOOL, in *Mining*, is used when the miners leave off digging deeper, and work in the ends forward. The end before them is called the *stool.*

STOOL, in *Ship building*, the name of the supporters of the poop and top lanterns.

STOOPING, in *Falconry*, is when a hawk, being upon her wings at the height of her pitch, bends down violently to take the fowl.

STOPPERS, in a ship, certain short pieces of rope, which are usually knotted at one or both ends, according to the purpose for which they are designed. They are either used to suspend any heavy body, or to retain a cable, shroud, &c. in a fixed position. Thus, the anchors, when first hoisted up from the ground, are hung to the cat head by a stopper attached to the latter, which passing through the anchor-ring, is afterwards fastened to the timber-head; and the same rope serves to fasten it on the bow at sea; or to suspend it by the ring which is to be sunk from the ship to the bottom. The stoppers of the cable have a large knot and a laniard at one end, and are fastened to a ring-bolt in the deck by the other. They are attached to the cable by the laniard, which is fastened securely round both by several turns passed behind the knot, or about the neck of the stopper; by which means the cable is restrained from running out of the ship when she rides at anchor.

The stoppers of the shroud have a knot and a laniard at each end. They are only used when the shrouds are cut asunder in battle, or disabled by tempestuous weather: at which time they are lashed, in the same manner as those of the cables, to the separated parts of the shroud, which are thereby reunited, so as to be fit for immediate service. This, however, is only a temporary expedient.

STOPS. See PUNCTUATION; and SCRIPTURE, N° 136.

STORAX. See STYRAX, MATERIA MEDICA *Index*.

STORK. See ARDEA, ORNITHOLOGY *Index*.

STOVE for heating apartments, greenhouses, hothouses, fruit-walls, &c.

When treating of the mechanical properties of air, we explained in sufficient detail the manner in which the expansion produced in a mass of air by heat produces that motion up our chimneys which is called the draught of the chimney; and, in the article SMOKE, we considered the circumstances which tend to check, to promote, or to direct this current, so as to free us from the smoke and vitiated air which necessarily accompanies the consumption of the fuel. In PNEUMATICS we also attended to the manner in which our fires immediately operate in warming our apartments. At present, when about to describe a method of warming intrinsically different, we must pay some more attention to the distinguishing circumstance. Without pretending to explain the physical connection of heat and light, it may suffice to observe, that heat, as well as light, is communicated to distant bodies in an instant by radiation. A person passing hastily by the door of a glass-house feels the glow of heat in the very moment he sees the dazzling light of the furnace mouth, and it is interrupted by merely screening his face with his hand. In this way is an apartment partly warmed by an open fire; and we avoid the oppressive heat by sitting where the fire is not seen, or by interposing a screen. We are apt to connect this so strongly in the imagination with the light emitted by the fire, that we attribute the heat to the immediate action of the light. But this opinion is shown to be gratuitous by a curious experiment made before the Royal Society by Dr Hooke, and afterwards, with more care and accurate examination, by Mr Scheele. They found, that by bringing a plate of the most transparent glass briskly between the fire and one's face, the heat is immediately intercepted without any sensible diminution of the light. Scheele, by a very pretty investigation, discovered that the glass made the separation, and did it both in refraction and reflection; for he found, that when the light of the same fire was collected into a focus by means of a polished metal concave speculum, a thermometer placed there was *instantly* affected. But if we employ a glass speculum foiled in the usual manner with quicksilver, of the same diameter and focal distance, and of equally brilliant reflection, there is hardly any sensible heat produced in the focus, and the thermometer must remain there for a very long while before it is sensibly affected. When we repeated this curious experiment, we found, that after the glass has remained a long while in this position, whether transmitting or reflecting the light, it loses in a great measure its power of intercepting the heat. By varying this observation in many of its circumstances, we think ourselves entitled to conclude, that the glass absorbs the heat which it intercepts, and is very quickly heated by the absorption. While it rises in its own temperature, it intercepts the heat powerfully; but when it is, as it were, saturated, attracting no more than what it immediately imparts to the air in corporeal contact with it, the heat passes freely through along with the light. If the

the glaſs be held ſo near the fire that the ſurrounding air is very much heated, no ſenſible interruption of heat is perceived after the glaſs is thus ſaturated. We found the cheek more quickly ſenſible than the thermometer of this inſtantaneous radiation of the heat which accompanies the light, or is ſeparated from it in this experiment. It is a very inſtructive experiment in the phyſiology of heat.

We cannot ſay how far this radiation of heat may extend, nor whether the accompanyment of light is abſolutely neceſſary. The mathematician proceeds on the ſuppoſition that it extends as far as the radiation of light, and that, being alſo rectilineal, the denſity of the heat is proportional to that of the light. But theſe notions are ſomewhat gratuitous; and there are appearances which render them doubtful. When with a lens of an inch in diameter we form a focus on a piece of black unpoliſhed marble of an inch diameter, the mathematician muſt allow that no more rays fall on the marble than if the lens were away: therefore the marble ſhould be equally warmed in either caſe. But it is by no means ſo, as we have repeatedly found by expoſing it during equal times, and then dropping it into water. The water which is heated by the marble on which the focus has been formed will be found to have acquired from it much more heat than from the other. The tops of lofty mountains which are never ſhaded by clouds, but enjoy perpetual ſunſhine and ſerenity, inſtead of being warmer than the valleys below, are covered with never-melting ſnow; and we have ſome grounds to ſuſpect that the genial influence of the ſun requires the co-operation of the atmoſphere, and to doubt whether there is any warmth at the moon, on which no atmoſphere like ours can be obſerved. Perhaps the heat which cheers us, and fertilizes our earth, is chemically ſeparated from our atmoſphere by its elective attraction for the light of the ſun. Our ſucceſſors in the ſtudy of meteorology need not fear that the ſubject of their reſearch will be ſoon deprived of ſcientific allurements. We know but little of it after all the progreſs we have made during this laſt century, and it ſtill preſents an ample field of diſcuſſion.

We ſaid that the accompaniment of light is not demonſtrably neceſſary. We are certain that heat may be imparted without any ſenſible light, in a manner which we can hardly ſuppoſe any thing but radiation. If a piece of very hot iron be placed a little without the principal focus of a metallic concave ſpeculum, and a very ſenſible air-thermometer be placed in its conjugate focus, it will inſtantly ſhow an elevation of temperature, although the iron is quite imperceptible to an eye which has even been a long while in the dark. No ſuch riſe of temperature is obſerved if the thermometer be placed a little to one ſide of the focus of the ſpeculum; therefore the phenomenon is preciſely ſimilar to the radiation of light. We are obliged therefore to acknowledge that the heat is radiated in this experiment in the ſame way that light is in the common optical experiments.

Although this is the moſt uſual way that we in this country employ fuel for warming our apartments, it is by no means the only way in which the heat diffuſed from this fuel may be imparted to diſtant bodies. It is not even the moſt effectual method; it is diffuſed alſo by immediate communication to bodies in contact. The air in immediate contact with the burning fuel is heated, and imparts ſome of its heat to the air lying beyond it, and this is partly ſhared with the air which is ſtill farther off; and this diffuſion, by communication *in contactu*, goes on till the remote air contiguous to the walls, the floor, the ceiling, the furniture, the company, all get a ſhare of it in proportion to their attractions and their capacities. And as the air is thus continually ſupplied, and continually gives out heat, the walls, &c. become gradually warmer, and the room becomes comfortable and pleaſant. But we apprehend that no great proportion of the heat actually acquired by the room is communicated in this way. This diffuſion by contact is but ſlow, eſpecially in air which is very dry; ſo ſlow indeed, that the air in the immediate neighbourhood of the fuel is hurried up the chimney before it has time to impart any of the heat received in contact. We know that the time employed in diffuſing itſelf in this way through ſtagnant air to any moderate diſtance is very conſiderable. We imagine therefore that the heat communicated to our rooms by an open fire is chiefly by radiation, but in a way ſomething different from what we mentioned before. We imagine, that as the piece of glaſs in Dr Hooke's experiment abſorbs the heat, ſo the whole maſs of air which fills the room intercepts the radiated heat in every part of the room where the fire is ſeen, and is as it were ſaturated with it throughout, and ready to impart it to every body immerſed in it. We cannot otherwiſe account for the *equability* of the heat in the different parts of the room. Mere radiation on the ſolid bodies would warm them in the inverſe duplicate ratio of their diſtances from the fire; and diffuſion by contact, if compatible with the rapid current up the chimney, would heat the room ſtill more unequably. Recollect how ſlowly, and with what rapid diminution of intenſity, the colour of blue vitriol is communicated to water even to a very ſmall diſtance. But becauſe all parts of the air of the room abſorb radiated heat, what is ſaturated at a higher temperature, being nearer to the fire, riſes to the ceiling, ſpreads outwards along the ceiling, and has its place ſupplied by the air, which is thus puſhed towards the fire from the places which are not directly illuminated.

Far different is the method of warming the room by a ſtove. Here the radiation, if any, is very feeble or ſcanty; and if a paſſage were allowed up the chimney for the warmed air, it would be quickly carried off. This is well known to the Engliſh who reſide in the cold climates of St Peterſburgh, Archangel, &c. They love the exhilerating flutter of an open fire, and often have one in their parlour; but this, ſo far from warming the room during the extreme cold weather, obliges them to heat their ſtoves more frequently, and even abſtracts the heat from a whole ſuite of apartments. But all paſſage this way is ſhut up when we warm a room by ſtoves. The air immediately contiguous to the ſtove is heated by contact, and this heat is gradually, though ſlowly, diffuſed through the whole room. The diffuſion would however be very ſlow indeed, were it not for the great expanſibility of air by heat. But the air ſurrounding the ſtove quickly expands and riſes to the ceiling, while the neighbouring air ſlides in to ſupply the place, nay is even puſhed in by the air which goes outwards aloft. Thus the whole air is ſoon mixed, and the room acquires almoſt an equal temperature throughout.

Stove.

The warming by ſtoves muſt therefore be managed upon very different principles from thoſe adopted in the employment of open fires. The general principle is, 1ſt, To employ the fuel in the moſt effectual manner for heating the external part of the ſtove, which is immediately efficient in warming the contiguous air; and, 2d, To keep in the room the air already warmed, at leaſt as much as is conſiſtent with wholeſomeneſs and cleanlineſs.

The firſt purpoſe is accompliſhed by conducting the flue of the furnace round its external parts, or, in ſhort, by making every part of the flue external. Of all forms, that of a long pipe, returned backwards and forwards, up and down (provided only that the place of its laſt diſcharge be conſiderably higher than its entry from the fire-place), would be the moſt effectual. We have ſeen a very ſmall ſtove conſtructed in this way, the whole being incloſed in a handſome caſe of poliſhed iron plate, pierced and cut into elegant foliage like the cock of a watch, ſo that the odd looking pipes were completely concealed. Though only three feet long, one foot thick, and ſix feet high, it warmed a very lofty room of 24 feet by 18, and conſumed leſs than half the fuel of a ſtove of the more uſual make, which did not ſo fully warm a ſmaller chamber.

It would occupy a volume to deſcribe the immenſe variety of ſtoves which ingenuity or architectonic taſte has conſtructed. We ſhall content ourſelves with giving a ſpecimen of the two chief claſſes into which they may be diſtinguiſhed.

The air of a room may be equally warmed, either by applying it to the ſurface of a ſmall ſtove made very hot, or to the ſurface of a much larger ſtove more moderately heated. The firſt kind is chiefly uſed in Holland, Flanders, and the milder climates of Germany and Poland. The laſt are univerſally uſed in the frozen climates of Ruſſia and Sweden. The firſt are generally made of caſt-iron, and the laſt of brick-work covered with glazed tiles or ſtucco.

Plate DX. Fig. 1.

Fig. 1. repreſents a ſmall German ſtove fully ſufficient for warming a room of 24 feet by 18. The baſe is about three feet broad and 14 inches deep, that is, from back to front, and ſix or ſeven feet high. The decoration is in the faſhion of that country; but the operative ſtructure of it will admit of any ſtyle of ornament. A, is the fire-place, and the wood or charred coal is laid on the bottom, which has no bars. Bars would admit the air too freely among the fuel, and would both conſume it too faſt and raiſe too great a heat. That no heat may be uſeleſsly expended, the ſole of the fire-place and the whole bottom of the ſtove is raiſed an inch or two above the floor of the room, and the air is therefore warmed by it in ſucceſſion, and riſes upwards. For the ſame reaſon the back of the ſtove is not in contact with the wall of the room, or of the niche in which it is placed. The fire-place is ſhut up by a door which fits cloſely to its caſe, and has a ſmall wicket at the bottom, whoſe aperture is regulated by a ſliding plate, ſo as to admit no more air than what ſuffices for ſlowly conſuming the fuel. The flame and heated air riſe to the top of the fire-place three or four inches above the arch or mantle-piece, and get out laterally by two narrow paſſages B, B, immediately below the top-plate of the baſe. The current bends downward on each ſide, paſſes at C, C, under the partition plates which divide the two ſide chambers, and then riſes upwards through the outer diviſion of each, and paſſes through narrow ſlits D, D, in the top plate, and from thence along the two hollow piers E, E. The two lateral currents unite at the top of the arch, and go through the ſingle paſſage F into the larger hollow behind the eſcutcheon G. From this place it either goes ſtraight upwards into the vent in the wall by a pipe on the top of the ſtove, or it goes into the wall behind by a pipe inſerted in the back of the ſtove. The propriety of this conſtruction is very obvious. The current of hot air is applied to exterior parts of the ſtove everywhere except in the two ſide chambers of the baſe, where the partition-plates form one ſide of the canal. Even this might be avoided by making each of theſe ſide-chambers a detached hollow pillar. But this would greatly increaſe the trouble of conſtruction and joining together, and is by no means neceſſary. The arch H has a graceful appearance, and affords a very warm ſituation for any thing that requires it, ſuch as a drink in a ſick perſon's bed-chamber, &c. Perſons of a certain claſs uſe this place for keeping a diſh warm; nay, the lower part of the arch is frequently occupied by an incloſed chamber, where the heat riſes high enough even for dreſſing victuals, as will be eaſily imagined when we reflect that the ſole of it is the roof of the fire-place.

The ſtove now deſcribed is ſupplied with fuel and with air by the front door opening into the room. That there may be room for fuel, this middle part projects a few inches before the two ſide-chambers. Theſe laſt, with the whole upper part of the ſtove, are not more than ten inches deep. The paſſages, therefore, from the fire-place are towards the back of it; ſo that if we have a mind to ſee the fire (which is always cheerful), the door may be thrown open, and there is no danger of the ſmoke coming out after the current has once warmed the upper part of the ſtove. When the ſtove is of ſuch dimenſions that the baſe is about two feet and a half or three feet high, the fire-place may be furniſhed with a ſmall grate in the Britiſh ſtyle. If the door is ſo hung that it can not only be thrown back, but lifted off its hinges, we have a ſtove grate of the completeſt kind, fully adequate, in our mild climate, to warm a handſome apartment, even with an open fire; and when we hang on the door, and ſhut up the fire-place, a ſtove of the dimenſions already given is almoſt too much for a large drawing room.

We have frequently remarked, that one ſide of theſe ſtoves grows much warmer than the other, and that it was difficult to prevent or remedy this; and we imagine that this is an unavoidable defect in all ſtoves with a double flue. It is ſcarcely poſſible to make the fire ſo equable in the fire-place, that one ſide ſhall not be a little warmer than the other, and a briſker current will then be produced in it. This muſt increaſe the conſumption of the fuel on this ſide, which will increaſe the current, will heat this ſide ſtill more, and thus go on continually till the fuel on this ſide is expended; after which the other ſide will obtain and increaſe the ſuperiority. The flue is made double, that the fire-place may occupy the middle of the front; and it will be difficult to gain this point of ſymmetry with one flue. The inconvenience may, however, be corrected by damping valves placed in ſome part of the upright funnels E, E.

In

In the colder winters on the continent, it is thought neceffary to increafe the effect by making the fire-place open to the back of the ftove. Its mouth or door communicates with or is joined to an opening of the fame dimenfions formed in the wall, and the door is on the other fide in an antichamber or lobby. In Weftphalia, and other places of Germany, the apartments are difpofed round a fpacious lobby, into which all their fire-places open, and are there fupplied with fuel. By this conftruction it is plain that the air of the room, already warmed by the ftove, is not carried off, and the room is more heated. But this method is very unfavourable to cheerfulnefs and health. The fame air, confined, and repeatedly breathed and compounded with all the volatile emanations of the room, quickly lofes that refrefhing quality that is fo defirable, and even fo neceffary for health. It is never renewed except by very partial admixtures when the room doors are thrown open, and becomes difagreeable to any perfon coming in from the open air; and in the houfes of the lefs opulent becomes really offenfive and naufeous.

Something of this is unavoidable in all rooms heated by ftoves. Even in our apartments in this ifland, perfons of delicate nerves are hurt by what they call the clofe air of a room; and it is long before the fmell of dinner is quite removed from a dining-room, notwithftanding the copious current up the chimney. This muft be incomparably more fenfible in a room heated by a ftove; and this inconvenience is peculiarly fenfible with refpect to the ftove which we are confidering at prefent, where we employ a fmall furface heated to a great degree.

Such ftoves are feldom made of any thing elfe than caft-iron. This (in thofe parts at leaft which are in immediate contact with the fuel) is in a ftate of continual calcination, and even throwing off fcales. This indeed is not feen, becaufe it is the bottom or fole of the fire-place which is fo heated: but the effect on the air of the room is the fame. The calcination of the iron is occafioned by the combination of pure vital air with the iron. This is abftracted from the general mafs of atmofpheric air in the room, of which it ufually conftitutes about two-fifths. By this abftraction the remainder becomes lefs fit for fupporting animal life or flame, and may even become highly deleterious. In every degree the remainder becomes lefs refrefhing, and grows dull and oppreffive. This is always accompanied by a peculiar fmell, which, though not difgufting, is unpleafant. It refembles the fmell of burnt feathers, or more exactly the fmell we feel if we rub violently for fome time the palms of our hands together when perfectly dry.

For fimilar reafons thefe iron ftoves occafion a fickly fmell, by burning every particle of duft which falls on the hot parts; and if they be wiped with a woollen cloth, or any cloth not perfectly free from every kind of greafy or oily matter, a fmell is produced for a day or days afterwards; fo that without the moft fcrupulous attention we fuffer by our very cleanlinefs.

For fuch reafons we think that the ftoves of brick-work covered with ftucco or with glazed tiles are vaftly preferable. Thefe are much ufed in the genteeler houfes in Flanders and Holland, where they are made in the moft elegant forms, and decorated with beautiful fculpture or enamel; but it is plain that they cannot be fo effectual, nor equally warm a room with the fame expence of fuel. Earthen ware, efpecially when covered with porous ftucco, is far inferior to metal in its power of conducting heat. If built of bricks, they muft be vaftly more bulky when the fire-place and flues are of the fame dimenfions. The moft perfect way of conftructing them would certainly be to make them of pottery, in parts exactly fitted to each other, and joined by a proper cement. This mode of conftructing would admit of every elegance of form or richnefs of ornament, and would not be fo bulky as thofe which are built of bricks. The great difficulty is to prevent their cracking by the heat. Different parts of the ftove being of very different heats, they expand unequally, and there is no cement which can withftand this, efpecially when we recollect that the fame heat which expands the baked earth caufes the clay or cement, with which the parts of the ftove are put together or covered, to contract. Accordingly thofe earthen ware ftoves feldom ftand a winter or two without cracking in fome place or other, even when ftrengthened by iron hoops and cramps judicioufly difpofed within them. Even hooping them them externally, which would be very unfightly, will not prevent this; for nothing can refift the expanfion and contraction by heat and cold. When a crack happens in a ftove, it is not only unfightly, but highly dangerous; becaufe it may be fo fituated, that it will difcharge into the room the air vitiated by the fire.

For thefe and other reafons, we can fcarcely hope to make ftoves of brick-work or pottery which fhall bear the neceffary heat without cracking; and their ufe muft therefore be confined to cafes where very moderate heat is fufficient. We need not defcribe their conftruction. It is evident that it fhould be more fimple than that of iron ftoves; and we imagine that in the very few cafes in which they are likely to be employed in this country, a fingle fire-place and an arch over it, divided, if we pleafe, by a partition or two of thin tile to lengthen the flue, will be quite enough. If the ftove is made in whole or in part of potters ware, a bafe for the fire-place, with an urn, column, obelifk, or pyramid above it, for increafing the furface, will alfo be fufficient. The failure commonly happens at the joinings, where the different pieces of a different heat, and perhaps of a different baking, are apt to expand unequally, and by working on each other one of them muft give way. Therefore, inftead of making the joints clofe and ufing any cement, the upper piece fhould ftand in a groove formed in the undermoft, having a little powdered chalk or clay fprinkled over it, which will effectually prevent the paffage of any air; and room being thus given for the unequal expanfion, the joint remains entire. This may be confidered as a general direction for all furnace-work, where it is in vain to attempt to hinder the mutual working of the parts.

We have feen ftoves in fmall apartments at St Peterfburg, which were made internally of potters ware, in a great variety of forms, and then covered with a thick coat of ftucco, finifhed externally with the utmoft elegance of ornament, and we were informed that they were very rarely fubject to crack. They did not give much heat, on account of the very low conducting power of the porous ftucco; but we imagine that they would be abundantly warm for a moderate room in this country.

When

When fitted up in thefe fituations, and with thefe precautions, the brick or pottery ftoves are incomparably more fweet and pleafant than the iron ones.

But in the intenfe colds of Ruffia and Sweden, or even for very large rooms in this kingdom, ftoves of thefe fmall dimenfions are not fufficiently powerful, and we muft follow the practice of thofe countries where they are made of great fize, and very moderately heated. It is needlefs to defcribe their external form, which may be varied at pleafure. Their internal ftructure is the fame in all, and is diftinctly defcribed in PNEUMATICS, N° 364. We fhall only enlarge a little on the peculiarities connected with the general principle of their conftruction.

The ftove is intended as a fort of magazine, in which a great quantity of heat may be quickly accumulated, to be afterwards flowly communicated to the air of the room. The ftove is therefore built extremely maffive; and it is found that they are more powerful when coated with clay as wet as can be made to hang together. We imagine the reafon of this to be, that very wet clay, and more particularly ftucco, muft be exceedingly porous when dry, and therefore a very flow conductor of heat. Inftead of fticking on the glazed tiles with no more clay or ftucco than is fufficient to attach them, each tile has at its back a fort of box baked in one piece about two or three inches deep. It is reprefented in

Fig. 2. fig. 2. This is filled with mortar, and then ftuck on the brick-work of the ftove, which has a great number of iron pins or hooks driven into the joints, which may fink into this clay and keep it firmly attached when dry. This coating, with the maffive brick-work, forms a great mafs of matter to be heated by the fuel. The loweft chamber, which is the fire-place, is fomewhat wider, and confiderably thicker than the ftories above, which are merely flues. When the fire-place is finifhed and about to be arched over, a flat iron bar of fmall thicknefs is laid along the top of the fide-wall on both fides, a fet of finifhing bricks being moulded on purpofe with a notch to receive the iron bar. Crofs bars are laid over thefe, one at each end and one or two between, having a bit turned down at the ends, which takes hold of the longitudinal bars, and keeps them from being thruft outwards either by the preffure of the arch or by the fwelling in confequence of the heat. In

Fig. 3. fig. 3. A is the crofs fection of one of the long bars, and BC is part of one of the crofs bars, and CD is the clench which confines the bar A. This precaution is chiefly neceffary, becaufe the contraction of the ftove upwards obliges the walls of the other ftories to bear a little on the arch of the fire-place. The building above is kept together in like manner by other courfes of iron bars at every fecond return of the flue. The top of the ftove is finifhed by a pretty thick covering of brick-work. The laft paffage for the air at H (fee PNEUMATICS, fig. 62.) has a ring lining its upper extremity, and projecting an inch or two above it. The flat round it is covered with fand. When we would ftop this paffage, a covered fhape like a bafon or cover for difhes at table is whelmed over it. The rim of this, refting on the fand, effectually prevents all air from coming through and getting up the vent. Accefs is had to this damper by a door which can be fhut tight enough to prevent the heated air of the room from wafting itfelf up the vent. When the room is too warm, it may be very rapidly cooled by opening this door. The warm air rufhes up with great rapidity, and is replaced by cool air from without.

The management of the ftove is as follows. About eight o'clock in the morning the *pietchnick*, or fervant who has the charge of the ftoves, takes off the cover, fhuts the damper-door, and opens the fire-place door. He then puts in a handful of wood fhavings or ftraw, and kindles it. This warms the ftove and vent, and begins a current of air through it. He then lays a few chips on the fole of the fire-place, immediately within the door; and behind this he arranges the billets of birchwood, with their ends inwards. Then he lays on more wood in the front, till he thinks there is enough. He fets fire to the chips, fhuts the door, and opens the fmall wicket at its bottom. The air blows the flame of the chips upon the billets behind them, and thus kindles them. They confume flowly, while the billets in front remain untouched by the fire. The fervant, having made his firft round of the rooms, returns to this ftove, and opens the door above to admit air into the vent. This is to fupply its draught, and thus to check the draught in the body of the ftove, which is generally too ftrong at this time, and would confume the fuel too faft. By this time the billets in the front are burning, firft at the bottom, and the reft in fucceffion as they fink down on the embers and come oppofite to the wicket. The room does not yet feel any effect from the fire, the heat of which has not yet reached its external furface; but in about half an hour this grows warm. The upper door is fhut again, that no heat may now be wafted. The pietchnick by and by fpreads the embers and afhes over the whole bottom of the fire-place with a rake, by which the bottom is greatly heated, and heats the air contiguous to it externally (for it ftands on little pillars) very powerfully. He takes care to bring up to the top of the afhes every bit of wood or coal that is not yet confumed, that all may be completely expended. He does this as brifkly as poffible, that the room may not lofe much warmed air by keeping open the fire-place door. At his laft vifit, when he obferves no more glowing embers, he fhuts the fire-place door and wicket, and puts the damper on the paffage above, and fhuts its door.—All this is over in about an hour and a half after kindling the fire. All current of air is now at an end within the ftove, and it is now a great mafs of brick-work, heated to a great degree within, but only about blood-warm externally. The heat gradually fpreads outwards, and the external furface of the ftove acquires its greateft heat about three o'clock in the afternoon; after which it gradually cools till next morning.

This heat feldom is fo great that one cannot bear to touch the ftove with his cheek, and to keep it there. In confequence of this it can burn none of the duft which unavoidably falls on the ftove, and we are never troubled with the fickening fmells that are unavoidable when we employ the fmall caft-iron ftoves much heated. The great expence of heat in a room arifes from the glafs windows. The pane is fo thin that the external air keeps it continually cold, and thus the windows are continually robbing the air of the room of its heat. This expence of heat is reduced to lefs than one-third by double cafements. The inner cafement is about as much colder than the room as the outer cafement is

 warmer

warmer than the air of the fields; and we have the singular advantage of having no ice formed on the glaffes. But to enfure this laft advantage, the feams of the inner cafement muft be pafted with paper, and thofe of the outer cafement muft be left unpafted. If we do the contrary, we fhall certainly have ice on the outer cafement; the reafon of which is eafily feen.

We have been thus particular in our defcription of the management, becaufe the reafons of fome particulars are not very obvious, and the practice would not readily occur to us in this country; fo that a perfon who, on the faith of our recommendation, fhould prefer one of thefe ftoves to the German ftove, whofe management is fimple and obvious, might be greatly difappointed. But by following this method, we are confident that the Ruffian ftove will be found much fuperior both in warmth and agreeable air. The fpreading out of the embers, and waiting till all is reduced to afhes before the doors are fhut, is alfo abfolutely neceffary, and a neglect of it would expofe us to imminent danger of fuffocation by fixed air; and this is the only inconvenience of the Ruffian ftove, from which the other ftove is free. The fixed air has no fmell; and the firft indication of its prefence is a flight giddinefs and laffitude, which difpofes us to fit down and to fleep. This would be fatal; and we muft immediately open the upper paffage and the fireplace door, fo as to produce a ftrong current to carry the vitiated air of the room up the chimney. Throwing up the fafhes, or at leaft opening all the doors, is proper on fuch an occafion.

If we burn pit-coal, either raw or charred, this precaution is ftill more neceffary; becaufe the cinder is not fo eafily or fo foon completely confumed. This fuel will require a little difference in the management from wood fuel, but which is eafily feen by any perfon of reflection. The fafe way would be to rake out all half-burnt coal before fhutting up the doors.

If we ufe raw pit-coal, great care is neceffary to prevent the accumulation of foot in the upper part of the ftove. It is an inacceffible place for the chimney-fweep; and if we attempt to burn it out, we run a great rifk of fplitting that part of the ftove which is the moft flightly conftructed. It is advifable therefore to burn it away every day, by giving a brifk draught with an open door for five minutes. With wood or coak there is no danger.

It will not be improper in this place to give fome inftructions for the conftruction of ftoves for warming feveral floors in a great manufactory, fuch as a cotton-mill, or a public library or mufeum.

In fuch fituations we think cleanlinefs, wholefomenefs, and fweetnefs of air, no lefs neceffary than in the drawing room of a man of opulence. We therefore recommend the brick-ftove in preference to the iron one; and though it would not be the beft or moft economical practice to heat it but once a-day, and we fhould rather prefer the German practice of conftant feeding, we ftill think it highly proper to limit the heat to a very moderate degree, and employ a large furface.

If the difpofition of the rooms allows us the conveniency of a thick party-wall, we would place the ftove in the middle of this wall, in an arch which pierces through the wall. Immediately above this arch we would carry up a very wide chimney through the whole height. This chimney muft have a paffage opening into each floor on both fides, which may be very accurately fhut up by a door. The ftove being fet up under the arch, it muft have a pipe communicating with its flue, and rifing up through this chimney. Could an earthen pipe be properly fupported, and fecured from fplitting by hoops, we fhould prefer it for the reafons already given. But as this is perhaps expecting too much, we muft admit the ufe of a caft iron pipe. This is the real chimney or flue of the ftove, and muft be of as great diameter as poffible, that it may act, by an extenfive furface, all the way up.

The ftove ftands under the arch in the wall; but the air that is warmed by its furface would efcape on both fides, and would be expended in that fingle floor. To prevent this, the ftove muft be inclofed in a cafe: this may be of brick-work, at the diftance of two or three inches from the ftove all round. It muft be well fhut in above, and at the foundation muft have a row of fmall holes to admit the air all around it. This air will then be warmed over the whole fpace between the ftove and the cafe, pafs up the chimney, and there receive additional heat from the flue-pipe which is in the middle. Great care muft be taken that the fire-place door have no communication with the fpace between the ftove and its cafe, but be inclofed in a mouth-piece which comes through the cafe, and opens into the feeding room. Thus all the air which goes up to the rooms will be pure and wholefome, provided we take care that every thing be kept clean and fweet about the air-holes below. Obferve that thofe air-holes which are near the furnace door muft be inclofed in a wooden trunk which takes in its air at fome diftance from this door; for fince the current between the ftove and cafe may be almoft as great as the current within the ftove (nay, when a puff of wind beats down the chimney, it may even exceed it), there is a rifk of fome vitiated air and fmoke being drawn into the cafe.

If the ftove cannot be placed in the arch of a party-wall, it may be fet adjoining to a fide or outer wall, and furnifhed with a cafe, a large chimney, and a flue-pipe, in the fame manner. But in this cafe a great deal of heat is wafted on this outer wall, and carried off by the external air. In this fituation we would recommend to line that part of the wall which is behind the ftove (at two or three inches diftance), and the whole of the chimney, with plafter on laths. Thefe fhould be nailed on battens properly faftened on the wall, leaving a fpace of an inch between the laths and the wall. The plafter fhould be of the moft fpungy kind, having in it a quantity of clay in powder inftead of the full proportion of fand. Horfe-dung, wafhed with water and ftrained through coarfe flannel, leaves a great portion of unaffimilated vegetable fibre, which will mix very intimately in the plafter, and make it a fubftance very unfit for conducting heat. There is no danger of catching fire by this lining. We have feen a moft tremendous fire rage for three hours, in contact with a partition of lath and plafter (on the plafter-fide however), without difcolouring the thin laths on the other fide. We once faw a cottage chimney on fire, and burn till the foot was confumed. This chimney was nothing but a pipe of a foot wide, made of laths, and plaftered on the infide and outfide; and it paffed through a thatched roof. We therefore recommend this in place of the brick-cafe for inclofing the ftove. It would fave heat; and as it might be be made in pieces on detached frames, which could be joined by iron ftraps and hinges, any part of the ftove could be laid open for repairs at pleafure.

We have no hefitation in faying that a ftove conftructed in this manner would be greatly fuperior in power to any we have feen, and would be free from many of their difgufting defects. We beg leave therefore to introduce here the defcription of one which was to have been erected in one of the churches of the city of Edinburgh.

Fig. 4.

Fig. 4. is a fketch of the plan of the church contained in the parallelogram AFED. P marks the place of the pulpit, and LMNO the front of the galleries. Thefe are carried back to the fide-walls AB and DC. But at the end oppofite to the pulpit they do not reach fo far, but leave a fpace BFEC about 12 feet wide. Below the back of the galleries, on each fide, there is a paffage ABGH, KICD, feparated from the feated part of the church by partitions which reach from the floor to the galleries, fo that the fpace HGIK is completely fhut in. The church is an ancient Gothic building, of a light and airy ftructure, having two rows of large windows above the arcades, and a fpacious window in the eaft end above the pulpit. The congregation complain of a cold air, which they feel pouring down upon their heads. This is more particularly felt by thofe fitting in the fronts of the galleries. We imagine that this arifes chiefly from the extenfive furface of the upper row of windows, and of the cold ftone-walls above, which robs the air of its heat as it glides up along the fides of the church. It becomes heavier by collapfing, and in this ftate defcends in the middle of the church.

The ftove S is placed againft the middle of the weft wall at the diftance of a few inches, and is completely inclofed in a cafe of lath and plafter. The vent, which is to carry off the fmoke and burnt air, is conveyed up or along the wall, and through the roof or fide-wall, but without any communication with the cafe. In like manner the fire-place door is open to the paffage, without communicating with the cafe; and care is taken that the holes which admit the air into the cafe are fo difpofed that they fhall run no rifk of drawing in any air from the fire-place door.

From the top of this cafe proceed two trunks Q, R, each of which is two feet broad and fix inches deep, coated within and without with the moft fpungy plafter that can be compofed. For this purpofe we fhould recommend a compofition of powdered charcoal and as much clay and quicklime as will give it a very flight cohefion. We know that a piece of this may be held in the hand, without inconvenience, within an inch of where it is of a glowing red heat.—Thefe trunks open into another trunk XVTYZ, which ranges along the partition immediately under the galleries, and may be formed externally into a corniche, a little maffive indeed, but not unfightly in a building of this ftyle. This trunk is coated in the fame manner. It has feveral openings *a*, *a*, &c. which have fliders that can be drawn afide by means of handles acceffible from the outer paffage.—At the extremities X and Z of this trunk are two perpendicular trunks which come up through the galleries, and are continued to a confiderable height. At their junction with the horizontal trunk are two doors large enough to admit a lamp. Each perpendicular trunk has alfo a valve by which it can be completely ftopped.

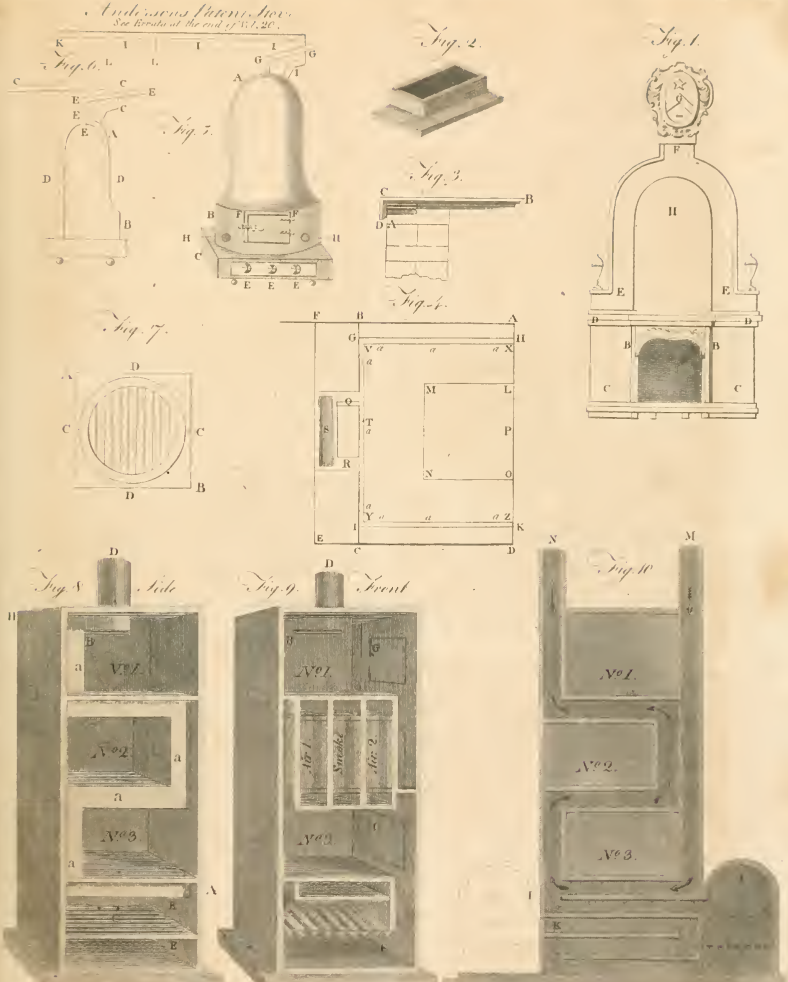
The ftove is managed as follows: Early in the morning the fuperintendant fhuts all the fliders, and fets a lamp (burning) in each of the trunks X and Z, and fhuts the doors. He then puts on and kindles the fire in the ftove, and manages it either in the Ruffian or German method. Perhaps the latter is preferable, as being liable to feweft accidents from miftake or neglect.

The lamps fet in the lower ends of the upright trunks prefently warm them, and produce a current of air upwards. This muft be fupplied by the horizontal trunk, which muft take it from the cafe round the ftove. Thus a current is begun in the direction we wifh. By and by the air in the cafe acquires heat from the ftove, and the current becomes extremely brifk. When the manager perceives this, he removes the lamps, fhuts the valves, and opens the holes *a*, *a*, &c. beginning with the moft remote, and proceeding flowly towards the ftove from each extremity of the horizontal branches. The heated air now iffues by thefe holes, glides along the ceiling below the galleries, and efcapes, by rifing up along the fronts of the galleries, and will be fenfibly felt by thofe fitting there, coming on their faces with a gentle warmth. It will then rife (in great part) ftraight up, while fome of it will glide backwards, to the comfort of thofe who fit behind.

The propriety of fhutting the valves of the upright trunks is evident. If they were left open, no air would come out by the holes *a*, *a*, &c.; but, on the contrary, the air would go in at thefe holes to fupply the current, and the ftove be rendered ufelefs. The air delivered by thefe holes will keep clofe to the ceiling, and will not, as we imagine, incommode thofe who fit below the galleries. But if it fhould be found to render thefe parts too warm, holes may be pierced through the ceiling, by which it will rife among the people above, and muft be very comfortable. It will require the careful attention of fome intelligent perfon to bring all this into a proper train at firft, by finding the proper apertures of the different holes, fo as to render the heat equable through the whole fpace. But this being once afcertained the difficulty is over.

The air trunks muft be very capacious, but may be contracted towards the extremities as their lateral difcharges diminifh; and the row of holes which admit the air to the cafe round the ftove muft be fully able to fupply them.

It muft be obferved, that in this conftruction the afcenfional force is but fmall. It is only the height of a fhort column of warm air from the ground to the galleries. At firft indeed it is great, having the unlimited height of the perpendicular trunks at X and Z; but during the ufe of the ftove it is reduced to nine or ten feet. It is neceffary, therefore, that the ftove be highly heated, perhaps confiderably beyond the Ruffian practice, but yet inferior to the heat of the German iron ftoves. But ftill we ftrongly recommend the brick or pottery ftoves, on account of the wholefome fweetnefs of the air which they furnifh; and we are certain that a ftove of moderate dimenfions, eight feet long, for inftance, by eight feet high, will be fufficient for warming a church holding 1200 or 1500 people. If the ftove could be placed lower, which in many fituations is very practicable, its effect would be proportionally greater, becaufe all depends on the rapidity of the current. When we are limited in height, we muft extend the ftove


Anderson's Patent Stove.
See Errata at the end of V.1.20.
Fig. 1.
Fig. 2.
Fig. 3.
Fig. 4.
Fig. 5.
Fig. 6.
Fig. 7.
Fig. 8 Side
Fig. 9. Front
Fig. 10
Nº 1.
Nº 2.
Nº 3.
Air 1.
Smoke
Air 2.

Stove. ſtove ſo much the more in length, and make the air trunks more capacious. Theſe and many other circumſtances of local modification muſt be attended to by the erector of the ſtove; and without the judicious attention of an intelligent artiſt, we may expect nothing but diſappointment. It is hardly poſſible to give inſtructions ſuited to every ſituation; but a careful attention to the general principle which determines the aſcenſional force will free the artiſt from any great riſk of failure.

We may ſay the ſame thing of ſtoves for conſervatories, hot-houſes, hot walls, &c. and can hardly add any thing of conſequence to what we have already ſaid on theſe heads in the article PNEUMATICS.

We muſt not, however, diſmiſs the ſubject without taking notice of the very ſpecious projects which have been frequently offered for drying malt by ſtoves. Many of theſe are to be ſeen in the publications of the Academies of Stockholm, Upſal, Copenhagen; and ſome have been erected in this kingdom, but they have not been found to anſwer.

We apprehend that they cannot anſwer. To dry malt, and make it fit for the ales and beers for which this iſland is ſo famous, it is by no means enough that we give it a proper and an equable ſupply of heat.—This alone would bake it and make it flinty, cauſing the moiſture to penetrate the mealy particles of the grain; and, by completely diſſolving the ſoluble parts, would render each kernel an uniform maſs, which would dry into a flinty grain, breaking like a piece of glaſs.—A grain of malt is not an inert pulp. It is a SEED, in an active ſtate, growing, and of an organized ſtructure. We wiſh to ſtop it in this ſtate, and kill it, not by heating it, but by abſtracting its moiſture. We thus leave it in its granulated or organized form, ſpungy, and fit for imbibing water in the maſh tub, without running into a paſte.

To accompliſh theſe purpoſes, the conſtruction of our malt kilns ſeems very well adapted. The kiln is the only flue of the furnace, and a copious *current* of air is formed through among the grains, carrying off with it the water which is evaporating by the heat. But this evaporation, being chiefly in conſequence of the vapour being immediately diſſolved by the paſſing air, will ſtop as ſoon as the current of air ſtops. This current has to make its way through moiſt grain, laid in a pretty thick bed, and matted together. Some force, therefore, is neceſſary to drive it through. This is furniſhed by the draught of the kiln. Subſtituting a ſtove, immediately applied to the malt, will not have this effect. The only way in which we think this can be done different from the preſent, is to have a horizontal flue, as has been propoſed in theſe projects, ſpread out at a ſmall diſtance below the grate on which the malt is laid, and to cover the whole with a high dome, like a glaſs-houſe dome. This being filled with a tall column of hot air, and having no paſſage into it but through the malt, would produce the current which we want. We are convinced that this will make much leſs fuel ſerve; but we are by no means certain that the ſulphureous and carbonic acid which accompanies the air in our common kiln is not a neceſſary or a uſeful ingredient in the proceſs. It is well known that different coaks, cinders, or charcoals, impart different qualities to the malts, and are preferred *each for its own purpoſe*.

A ſtove conſtructed on ſimilar principles, but compoſed of very different materials, has been lately erected in ſeveral of the churches in Edinburgh. This ſtove, which is formed entirely of caſt iron, may be conſidered as a double ſtove, an outer caſe, and a furnace or inner ſtove. The fuel is burnt in the inner ſtove; and the ſmoke produced during the proceſs of combuſtion, is carried off by a chimney, which paſſes through the top of the outer ſtove, and is conveyed to the outſide of the building. The outer caſe includes not only the furnace or inner ſtove, but alſo a conſiderable ſpace, occupied by the air of the atmoſphere, which is freely admitted through a number of openings placed around it; and when any current of air is produced, it paſſes off from the ſpace between the outer caſe and inner ſtove, and is conveyed by tubes through the body of the apartment. But we ſhall firſt deſcribe the different parts of which the ſtove is compoſed, after which we ſhall be better able to underſtand its mode of operation.

Fig. 5. exhibits a perſpective view of this ſtove. AB is the body, which is about three feet high, and of a circular form. BC is a ſquare pedeſtal on which the ſtove is placed, and which contains the aſh pit DD. The height of the pedeſtal is about a foot, and it is nearly inſulated by reſting on the ſpherical ſupports *a a*, alſo of caſt iron. EEE are openings in front of the aſh pit through which the air enters to ſupport the combuſtion. Theſe openings can be enlarged or diminiſhed, or opened and ſhut at pleaſure. FF is the door of the furnace through which the fuel is introduced. This door is attached to the inner furnace, and is double. It is one foot broad, and 11 inches high. GG is the chimney, which paſſes from the furnace within, through the outer caſe, and conveys the ſmoke out of the building. HH are openings in the outer caſe, and are eight in number, through which the air enters, and being heated, is greatly rarified, and paſſes off through the funnel or pipe IIII. This pipe communicates only with the outer ſtove, and being ſhut at the end K, the air ruſhes out from the ſmall tubes LL, inſerted into the ſide of the pipe IIII, and thus mixes with the cold air of the church. The diameter of the outer caſe at the bottom is about two feet, and the diameter of the furnace within is about 16 inches.

Fig. 6. is a ſection of the ſtove. AB is the outer caſe, from which paſſes off the pipe or funnel CCC, by which the heated air is conveyed through the church. DD is the furnace in the inſide, in which the fuel is burnt, and EEE is the chimney or funnel which conveys the ſmoke from the inner furnace out of the building. It paſſes through the outer ſtove AB at F.

Fig. 7. is a plan of this ſtove. AB is the pedeſtal on which it reſts, and which contains the aſh pit. CC is the outer caſe, and DD is the furnace within, in which are ſeen the tranſverſe bars which ſupport the fuel.

The length of the body of the church, in which two ſtoves of the form and dimenſions now deſcribed are erected, is about 60 feet, and the breadth is about 45 feet. The tubes IIII are conveyed along the lower edge of the gallery, about half the length of the church. The fires are lighted up about four or five o'clock on the Sunday morning, during the earlier part of the cold ſeaſon; but as the ſeaſon advances, it is uſual to light them up the night before. From this time till the congregation aſſemble for the afternoon ſervice, the furnaces are

are kept conſtantly ſupplied with fuel. By this management the air in the church is kept comfortably warm during the coldeſt ſeaſon of the year.

Theſe ſtoves, it appears to us, are ſuſceptible of ſome improvement, both in their conſtruction and in the places in which they are erected. With regard to the firſt circumſtance, an external coating of plaſter work, or of the ſame kind of materials as are uſed for coating the inſide of chemical furnaces, would be of ſome uſe in preventing an unneceſſary waſte of heat, as well as the diſagreeable ſmell which is ſometimes complained of, and which is ſuppoſed to ariſe from the combuſtion of light bodies floating in the air and drawn by the current to the heated metal; and with regard to the laſt, viz. the places in which they are erected, it is perfectly obvious that they ought to be as completely inſulated as poſſible, and particularly ought not to communicate with any body which is a good conductor of heat. Some of the ſtoves erected in the churches of Edinburgh, which we have examined, are faulty in this reſpect. One in particular is placed in cloſe contact with a gable wall.

The quantity of coals conſumed in two of theſe ſtoves in one of the churches of Edinburgh during the courſe of a ſeaſon, we have been informed, amounts to about five carts of 12 cwt. each; ſo that at the Edinburgh prices of coal, the expence for fuel for heating one of the churches is about 50 ſhillings. This being added to the expences of attendance, includes the whole expenditure, beſides ſome occaſional repairs which are required in heating a church of the above dimenſions.

The following is the deſcription of an improved ſtove by Mr Field of Newman Street London, in which, it is ſtated by the author, the various advantages of heating, boiling, ſteaming, evaporating, drying, ventilating, &c. are united; ſome of which we ſhall detail in his own words.

"Fig. 8. repreſents a longitudinal ſection of the ſtove, ſhowing the courſe of the air from its entrance into the flues of the ſtove at A, to its entrance into the upper chamber of the ſtove at B; and alſo the courſe of the ſmoke from the fire-place at C, till it eſcapes from the ſtove at D. E, E, are the doors or openings of the fire-place and aſh-hole.

"Fig. 9. is a ſimilar ſection at right angles with the above, exhibiting the courſe of the air through the chambers of the ſtove, from its entrance into the chamber N° 1. at B to its entrance beneath the fire-place at F. This figure alſo ſhows ſections of the flues, with the diviſions through which the air and ſmoke paſs ſeparately, the ſmoke-flue in the centre, and the air-flues on each ſide. G, G, are doors and openings through which the articles to be dried are introduced into the chambers.

"When the fire is lighted, and the doors of the chambers, aſh-hole, and fire-place, cloſed, the air by which the fire is ſupplied enters at A, fig 8. paſſes through the air-flues *a*, *a*, *a*, *a*, enters the upper chamber at B, traverſes and deſcends through the chambers N° 1, 2, 3, and arrives beneath the fire at F, fig. 9. Having ſupplied the fire with oxygen, it paſſes through the flue with the ſmoke, and eſcapes at D, heating in its protracted courſe the chambers and air-flues.

"As the cold air enters the ſtove at A, immediately above a plate forming the top of the fire-place, and purſues a ſimilar route with the fire-flue, it enters the chambers very much heated and rarefied. Hence any moiſt ſubſtance placed in the chambers evaporates in conſequence, not only of the heated flues circulating round them, but of a ſtream of warm rarefied air, which, while it continually raiſes evaporation, as continually bears away the exhaled moiſture in its paſſage to the fire, thus imitating the gradual and efficacious plan of nature in drying by the ſun and air. While theſe effects are taking place within the ſtove, part of the air which enters at A, fig. 8. and 9. paſſes through air-flues on the other ſide of the fire-flue, purſues a parallel courſe with the firſt, and gives out a current of warm air to the room at an aperture H. This effect may be obtained in a much higher degree, if the doors of the chambers and aſh-hole are opened: ſhould the hand or face be then brought near, they would be fanned with a ſtream of warm air, eſpecially from the upper chamber.

"By means of this ſtove I have evaporated milk to dryneſs, without burning or diſcolouring it; and have dried cherries, plums, and other fruits, ſo as to imitate thoſe which are received from abroad. I have repeatedly dried colours and the moſt delicate ſubſtances without the ſlighteſt injury, even though the operation proceeded quickly.

"The height of the ſtove is about five feet and a half; its diameter two feet and a half, and that of the flues four inches. The external part is conſtructed of brick, and the internal parts of thin Ryegate or fire-ſtone, except the top of the fire-place, which is a plate of caſt iron. Were it to be wholly formed of iron, its effects would neceſſarily be more powerful.

"Fig. 10. repreſents an extenſion of the plan, in which ſtoves of this kind may be advantageouſly connected with one or more furnaces for chemical or other uſes. The fire-place, brought out, either in front or on one ſide, by the preſent poſitions of its crown I, forms a reverberatory furnace, or will make a ſand-bath by reverſing it.

"The ſpace occupied by the fire-place in fig. 8. may in this be converted into apartments for evaporating ſubſtances, or occaſionally for cooling them by an opening at K to admit cold air, while the warm air of the ſtove is excluded by a regiſter or door. The dotted lines ſhow the manner in which a ſecond furnace may be connected by an opening into the flue at L.

"In addition to the uſes already pointed out, this ſtove would probably be found extremely ſerviceable in drying japanners goods, and conſuming the noxious fumes and gas which ariſe from the oil and varniſh uſed in this buſineſs.

"Since the ſtove is not limited to any certain dimenſions, it might be adapted to the drying of malt and hops, perhaps of herbs, corn, and ſeeds generally. It might alſo be accommodated to the purpoſes of the ſugar-bakers, connected with the great fires they employ for their boilers. It has been ſhown to be uſeful in the confectioners art, and probably it may be equally ſo in baking biſcuits for the navy; nor leſs ſo in drying linen for the laundreſs, dyer, calico-printer, and bleacher. I have myſelf found it well accommodated for a chemical elaboratory *."

* Phil. Mag. vol. xxvii.

STOURBRIDGE, or STURBICH, the name of a field near Cambridge, noted for its famous fair kept annually on the 7th of September, and which continues for a fortnight. The commodities are, horſes, hops, iron, wool, leather, cheeſe, &c. This place is alſo noted

noted for an excellent species of clay capable of resisting an intense heat. It is used in making pots for glass-houses, fire-bricks, &c.; and is sold at an high price.

STOW, the name of a market-town in Gloucestershire in England, situated in W. Long. 1. 50. N. Lat. 51. 54. It is also the name of a fine seat of the marquis of Buckingham in Buckinghamshire. Here are the best gardens in England, adorned with busts, statues, obelisks, pavilions, and temples. It is two miles from the town of Buckingham.

STOW, *John*, the industrious historian, son of Thomas Stow merchant-taylor of St Michael's, Cornhill, in London, was born about the year 1525. Of the early part of his life we know very little, except that he was bred to his father's business, which in the year 1560 he relinquished, devoting himself entirely to the study of our ancient historians, chronicles, annals, charters, registers, and records. Of these he made a considerable collection, travelling for that purpose to different parts of the kingdom, and transcribing such manuscripts as he could not purchase. But this profession of an antiquary being attended with no present emolument, he was obliged for subsistence to return to his trade.—It happened, however, that his talents and necessities were made known to Dr Parker archbishop of Canterbury; who being himself an antiquary, encouraged and enabled Mr Stow to prosecute his darling study. In those times of persecution, though Elizabeth was then upon the throne, honest John Stow did not escape danger. His collection of Popish records was deemed cause of suspicion. His younger brother Thomas preferred no less than 140 articles against him before the ecclesiastical commission; but the proof being insufficient, he was acquitted. In 1565 he first published his Summary of the Chronicles of England. About the year 1584 he began his Survey of London. In 1585 he was one of the two collectors for a great muster of Limestreet ward: in the same year he petitioned the corporation of London to bestow on him the benefit of two freemen, to enable him to publish his survey; and in 1589 he petitioned again for a pension. Whether he succeeded, is not known. He was principally concerned in the second edition of Holinshed's chronicle, published in 1587. He also corrected, and twice augmented, Chaucer's works, published in 1561 and in 1597. His survey of London was first published in 1598. To these laborious works he would have added his large Chronicle, or History of England; but he lived only to publish an abstract of it, under the title of *Flores Historiarum*. The folio volume, which was printed after his death, with the title of *Stow's Chronicle*, was taken from his papers by Edmund Howes. Having thus spent his life and fortune in these laborious pursuits, he was at last obliged to solicit the charitable and well disposed for relief. For this purpose, King James I. granted him, in 1603, a brief, which was renewed in 1604, authorizing him to collect in churches the benefactions of his fellow-citizens. He died in April 1605, aged 80; and was buried in his parish church of St Andrew's, Undershaft, where his widow erected a decent monument to his memory. John Stow was a most indefatigable antiquarian, a faithful historian, and an honest man.

STOWMARKET, a town of Suffolk, in England, situated in E. Long. 1. 6. N. Lat. 52. 16. It is a large handsome place, situated between the branches of the rivers Gypping and Orwell, and is remarkable for having the best cherries in England.

STOWAGE, the general disposition of the several materials contained in a ship's hold, with regard to their figure, magnitude, or solidity.

In the stowage of different articles, as ballast, casks, cases, bales, and boxes, there are several general rules to be observed, according to the circumstances or qualities of those materials. The casks which contain any liquid are, according to the sea phrase, to be *bung-up* and *bilge-free*, i. e. closely wedged up in an horizontal position, and resting on their quarters: so that the bilges where they are thickest being entirely free all round, cannot rub against each other by the motion of the vessel. Dry goods, or such as may be damaged by the water, are to be carefully inclosed in casks, bales, cases, or wrappers; and wedged off from the bottom and sides of the ship, as well as from the bow, masts, and pump-well. Due attention must likewise be had to their disposition with regard to each other, and to the trim and centre of gravity of the ship; so that the heaviest may always be nearest the keel, and the lightest gradually above them.

STRABISMUS, squinting. See MEDICINE *Index*.

STRABO, a celebrated Greek geographer, philosopher, and historian, was born at Amasia, and was descended from a family settled at Gnossus in Crete. He was the disciple of Xenarchus, a Peripatetic philosopher, and at length attached himself to the Stoics. He contracted a strict friendship with Cornelius Gallus, governor of Egypt, and travelled into several countries to observe the situation of places, and the customs of nations. He flourished under Augustus, and died under Tiberius about the year 25, in a very advanced age.—He composed several works, all of which are lost except his Geography in 17 books; which are justly esteemed very precious remains of antiquity. The two first books are employed in showing, that the study of geography is not only worthy of, but even necessary to, a philosopher; the third describes Spain; the fourth, Gaul and the Britannic isles; the fifth and sixth, Italy and the adjacent isles; the seventh, which is imperfect at the end, Germany, the countries of the Getæ and Illyrii, Taurica Chersonesus, and Epirus; the eighth, ninth, and tenth, Greece with the neighbouring isles; the four following, Asia within Mount Taurus; the fifteenth and sixteenth, Asia without Taurus, India, Persia, Syria, Arabia; and the seventeenth, Egypt, Æthiopia, Carthage, and other places of Africa. Strabo's work was published with a Latin version by Xylander, and notes by Isaac Casaubon, (or rather by Henry Scrimzeer, from whom Casaubon chiefly stole them), at Paris, 1620, in folio. But the best edition is that of Amsterdam in 1707, in two volumes folio, by the learned Theodore Jansonius ab Almelooveen, with the entire notes of Xylander, Casaubon, Meursius, Cluver, Holstenius, Salmasius, Bochart, Ez. Spanheim, Cellarius, and others. To this edition is subjoined the *Chrestomathiæ*, or epitome of Strabo; which according to Mr Dodwell, who has written a very elaborate and learned dissertation about it, was made by some unknown person between the years of Christ 676 and 996. It has been found of some use,

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not only in helping to correct the original, but in supplying in some measure the defect in the seventh book. Mr Dodwell's dissertation is prefixed to this edition.

STRADA, Famianus, a very ingenious and learned Jesuit, was born at Rome in the latter end of the 16th century, and taught rhetoric there, in a public manner, for fifteen years. He wrote several pieces upon the art of oratory, and published some orations with a view of illustrating by example what he had inculcated by precept. But his *Prolusiones Academicæ* and his *Historia de Bello Belgico* are the works which raised his reputation, and have preserved his memory. His history of the war of Flanders was published at Rome; the first decad in 1640, the second in 1647; the whole extending from the death of Charles V. which happened in 1558, to the year 1590. It is written in good Latin, as all allow; but its merit in other respects has been variously determined. His *Prolusiones Academicæ* show great ingenuity, and a masterly skill in classical literature; that prolusion especially in which he introduces Lucan, Lucretius, Claudian, Ovid, Statius, and Virgil, each of them versifying according to his own strain. They have been often printed. We know not the year of Strada's birth or of his death.

STRAHAN, William, an eminent printer, was born at Edinburgh in the year 1715. His father, who had a small appointment in the customs, gave his son the education which every one of decent rank then received in a country where the avenues to learning were easy, and open to men of the most moderate circumstances. After having passed through the tuition of a grammar school, he was put apprentice to a printer; and when a very young man, removed to a wider sphere in that line of business, and went to follow his trade in London. Sober, diligent, and attentive, while his emoluments were for some time very scanty, he contrived to live rather within than beyond his income; and though he married early, and without such a provision as prudence might have looked for in the establishment of a family, he continued to thrive, and to better his circumstances. This he would often mention as an encouragement to early matrimony; and used to say, that he never had a child born that Providence did not send some increase of income to provide for the increase of his household. With sufficient vigour of mind, he had that happy flow of animal spirits that is not easily discouraged by unpromising appearances.

His abilities in his profession, accompanied with perfect integrity and unabating diligence, enabled him, after the first difficulties were overcome, to advance with rapid success. And he was one of the most flourishing men of the trade, when, in the year 1770, he purchased a share of the patent for king's printer of Mr Eyre, with whom he maintained the most cordial intimacy during the rest of his life. Beside the emoluments arising from this appointment, as well as from a very extensive private business, he now drew largely from a field which required some degree of speculative sagacity to cultivate on account of the great literary property which he acquired by purchasing the copy-rights of the most celebrated authors of the time. In this his liberality kept pace with his prudence, and in some cases went perhaps rather beyond it. Never had such rewards been given to the labours of literary men as now were received from him and his associates in those purchases of copy-rights from authors.

Having now attained the first great object of business, wealth, Mr Strahan looked with a very allowable ambition on the stations of political rank and eminence, Politics had long occupied his active mind, which he had for many years pursued as his favourite amusement, by corresponding on that subject with some of the first characters of the age. Mr Strahan's queries to Dr Franklin in the year 1769, respecting the discontents of the Americans, published in the London Chronicle of 28th July 1778, show the just conception he entertained of the important consequences of that dispute, and his anxiety as a good subject to investigate, at that early period, the proper means by which their grievances might be removed, and a permanent harmony restored between the two countries, In the year 1775 he was elected a member of parliament for the borough of Malmsbury in Wiltshire, with a very illustrious colleague, the Hon. C. J. Fox; and in the succeeding parliament, for Wootton Basset, in the same county. In this station, applying himself with that industry which was natural to him, he was a useful member, and attended the house with a scrupulous punctuality. His talents for business acquired the consideration to which they were intitled, and were not unnoticed by the minister.

In his political connection he was constant to the friends to whom he had first been attached. He was a steady supporter of that party who were turned out of administration in spring 1784, and lost his seat in the house of commons by the dissolution of parliament with which that change was followed: a situation which he did not shew any desire to resume on the return of the new parliament; arising from a feeling of some decline in his health, which had rather suffered from the long sittings and late hours with which the political warfare in the preceding had been attended. Without any fixed disease, his strength visibly declined; and though his spirits survived his strength, yet the vigour and activity of his mind were considerably impared. Both continued gradually to decline till his death, which happened on the 9th of July 1785 in the 71st year of his age.

Endued with much natural sagacity, and an attentive observation of life, he owed his rise to that station of opulence and respect which he attained, rather to his own talents and exertion, than to any accidental occurrence of favourable or fortunate circumstances. His mind was not uninformed by letters; and from a habit of attention to style, he acquired a considerable portion of critical acuteness in the discernment of its beauties and defects? In one branch of writing he particularly excelled—the epistolary; in which he not only showed the precision and clearness of business, but possessed a neatness as well as a fluency of expression which few letter-writers have been known to surpass. Letter-writing was one of his favourite amusements; and among his correspondents were men of such eminence and talents as well repaid his endeavours to entertain them. Among these, as before mentioned, was the justly celebrated Dr Franklin, originally a printer like Mr Strahan, whose friendship and correspondence, notwithstanding the difference of their sentiments in political matters,

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he continued to enjoy till his death. One of the lateſt letters which he received from his illuſtrious and venerable friend contained a humorous allegory of the ſtate of politics in Britain, drawn from the profeſſion of printing; of which, though the doctor had quitted the exerciſe, he had not forgotten the terms.

The judicious diſpoſition which Mr Strahan made of his property, affords an evident proof of his good ſenſe and propriety. After providing munificently for his widow and children, his principal ſtudy ſeems to have been to mitigate the affliction of thoſe (and many there were) who would more immediately have felt his loſs, by bequeathing them liberal annuities for their lives; and (recollecting that all of a profeſſion are not equally provident) he left 1000l. to the Company of Stationers, the intereſt to be divided among infirm old printers.

As the virtuous connections of the life and the heart are always pleaſing to trace,—of Mr Strahan it may briefly be ſaid, that his capacity, diligence, and probity, raiſed him to the head of his profeſſion. The good humour and obliging diſpoſition which he owed to nature, he cultivated with care, and confirmed by habit. His ſympathetic heart beat time to the joy and ſorrow of his friends. His advice was always ready to direct youth, and his purſe open to relieve indigence. Living in times not the pureſt in the Engliſh annals, he eſcaped unſullied through the artifices of trade and the corruption of politics. In him a ſtrong natural ſagacity, improved by an extenſive knowledge of the world, ſerved only to render reſpectable his unaffected ſimplicity of manners, and to make his Chriſtian philanthropy more diſcerning and uſeful. The uninterrupted health and happineſs which accompanied him for half a century in the capital, proves honeſty to be the beſt policy, temperance the greateſt luxury, and the eſſential duties of life its moſt agreeable amuſement. In his elevated fortune, none of his former acquaintance ever accuſed him of neglect. He attained proſperity without envy, enjoyed wealth without pride, and diſpenſed bounty without oſtentation.

STRAIKS, in the military art, are ſtrong plates of iron, ſix in number, fixed with large nails called *ſtraik-nails*, on the circumference of a cannon-wheel, over the joints of the fellows; both to ſtrengthen the wheel, and to ſave the fellows from wearing on hard ways or ſtreets.

STRAIN, a pain occaſioned by the violent extenſion of ſome membranous or tendinous part.

STRAIN, *Streſs*, in *Mechanics*, are terms indiſcriminately uſed to expreſs the force which is *excited* in any part of a machine or ſtructure of any kind tending to break it in that part. Thus every part of a rope is *equally* ſtrained by the weight which it ſuſpends. Every part of a pillar is *equally* ſtrained by the load which it ſupports. A mill axle is *equally* twiſted and ſtrained in every part which lies between the part of the wheel actuated by the moving power and the part which is reſiſted by the work to be performed. Every part of a lever or joiſt is *differently* ſtrained by a force acting on a diſtant part.

It is evident that we cannot make the ſtructure fit for its purpoſe, unleſs the ſtrength at every part be at leaſt equal to the ſtreſs laid on, or the ſtrain excited in that part. It is no leſs plain, that if we are ignorant of the principles which determine this ſtrain, both in intenſity and direction, in relation to the magnitude and the ſituation of its remote cauſe, the only ſecurity we have for ſucceſs is to give to every part of the aſſemblage ſuch ſolidity that we can leave no doubt of its ſufficiency. But daily experience ſhows us that this vague ſecurity is in many caſes uncertain, if we are thus ignorant. In all caſes it is ſlovenly, unlike an artiſt, attended with uſeleſs expence, and in machines is attended with a loſs of power which is waſted in changing the motions of a needleſs load of matter.

It muſt therefore greatly tend to the improvement of all profeſſions occupied in the erection or employment of ſuch ſtructures, to have a diſtinct notion of the ſtrains to which theſe parts are expoſed. Frequently, nay generally, theſe ſtrains are not immediate, but ariſe from the action of forces on diſtant parts, by which the aſſemblage is ſtrained, and there is a tendency to rupture in every part. This ſtrain is *induced* on every part, and is there modified by fixed mechanical laws. Theſe it is our buſineſs to learn; but our chief object in this inveſtigation is to determine the ſtrength of materials which it is neceſſary to oppoſe in every part to this ſtrain; and how to oppoſe this ſtrength in ſuch a manner that it ſhall be exerted to the beſt advantage. The notions of ſtrain and ſtrength therefore hardly admit of ſeparation; for it is even by means of the ſtrength of the intermediate parts that the ſtrain is propagated to, or excited in, the part under conſideration. It is proper therefore to conſider the whole together under the article *STRENGTH of Materials* in mechanics.

STRAINING, is the clarification of a liquor, by paſſing it through a ſieve or filter. The word is derived from the French, *eſtreindre;* which is formed from *ex*, "out of," and *ſtringere*, "to preſs."

STRAIT, a narrow channel or arm of the ſea, ſhut up between lands on either ſide, and affording a paſſage out of one great ſea into another.

There are three kinds of ſtraits. 1. Such as join one ocean to another. Of this kind are the ſtraits of Magellan and Le Maire. 2. Thoſe which join the ocean to a gulf: the ſtraits of Gibraltar and Babelmandel are of this kind, the Mediterranean and Red ſea being only large gulfs. 3. Thoſe which join one gulf to another; as the ſtraits of Caffa, which join the Palus Mæotis to the Euxine or Black ſea. The paſſage of ſtraits is commonly dangerous, on account of the rapidity and oppoſite motion of currents. The moſt celebrated ſtrait in the world is that of Gibraltar, which is about from 24 to 36 miles long, and from 15 to 24 broad, joining the Mediterranean ſea with the Atlantic ocean. The ſtraits of Magellan, diſcovered in 1520 by F. Magellan, were uſed ſome time as a paſſage out of the North into the South ſea; but ſince the year 1616, that the ſtrait of Le Maire has been diſcovered, the former has been diſuſed; both becauſe of its length, which is full three hundred miles, and becauſe the navigation thereof is very dangerous, from the waves of the North and South ſeas meeting in it and claſhing. The ſtrait at the entrance of the Baltic is called the *Sound;* that between England and France, *Le pas de Calais*, or the *Channel*. There are alſo the ſtraits of Weigats, of Jeſſo, of Anian, of Davis, and Hudſon, &c.

STRAKES, or STREAKS, in a ſhip, the uniform ranges of planks on the bottom and ſides of a ſhip, or the continuation of planks joined to the ends of each other,

other, and reaching from the ftem to the ftern-poft and fafhion-pieces; the loweft of thefe, which is called the *garboard-ftreak*, is let into the keel below, and into the ftem and ftern-poft. They fay alfo a *fhip heels a ftrake*, that is, hangs or inclines to one fide the quantity of a whole plank's breadth.

Strakes, or *ftreks*, in mining, are frames of boards fixed on or in the ground, where they wafh and drefs the fmall ore in a little ftream of water, hence called *ftraked ore*.

STRALSUND, a ftrong and rich fea-port town of Germany, in Hither Pomerania, formerly an important trading-place. In 1678 it was forced to furrender to the elector of Brandenburg, after 1800 houfes had been burnt to afhes in one night's time. After this the Swedes defended it to the laft extremity; and Chas. XII. in 1714, came hither after his return out of Turkey. But the thrown of Sweden not being able to hold out againft five great powers, it was forced to fubmit in 1715. In 1720 it was rendered back to Sweden, but in a very poor condition. It is almoft furrounded by the fea and the lake Francen, and has a harbour feparated from the ifle of Rugen by a narrow ftrait. It is 15 miles northweft of Grippfwald, and 40 north-eaft of Guftrow. E. Long. 13. 28. N. Lat. 54 17.

STRAMONIUM, a fpecies of plant. See Datura, Botany *Index*.

STRAND (*Saxon*), any fhore or bank of a fea or great river. Hence the ftreet in the weft fuburbs of London, which lay next the fhore or bank of the Thames, was called the *Strand*. An immunity from cuftom, and all impofitions upon goods or veffels by land or water, was ufually expreffed by *ftrand* or *ftream*.

STRANDED (from the Saxon *ftrand*), is when a fhip is by tempeft, or by ill fteerage, run on ground, and fo perifhes. Where a veffel is ftranded, juftices of the peace, &c. fhall command conftables near the fea-coafts to call affiftance for the prefervation of the fhip; and officers of men of war are to be aiding and affifting thereto.

STRANGE, Sir Robert, an eminent engraver, who carried the art to great perfection in this country, and was diftinguifhed not only as an artift, but highly refpected and beloved on account of his private virtues and domeftic habits. Modeft as he was ingenious, he ufed to fay that the works of an artift fhould ferve for his life and monument. His works no doubt will perpetuate his name whilft any tafte for the fine arts remains.

Sir Robert Strange was born in the ifland of Pomona in Orkney, July the 14th 1721; and died at London July the 5th 1792. He was lineally defcended from David Strange or Strang, a younger fon of the family of the Stranges or Strangs of Balcafky, in the county of Fife, who fettled in Orkney at the time of the Reformation. But as there were no males remaining of the elder branch of the Stranges of Balcafky, Sir Robert became the male reprefentative of it, and was found by a legal inveftigation to have a right to the armorial bearings and every other mark of honour belonging to that ancient family.

He received his claffical education at Kirkwall in Orkney, under the care of a learned, worthy, and much refpected gentleman, Mr Murdoch Mackenzie, who has rendered infinite fervice to his country by the accurate furveys and charts he has given of the iflands of Orkney, and of the Britifh and Irifh coafts.

Originally intended for the law, Mr Strange foon became tired of that profeffion, and perceived that his genius decifively led him to the arts of drawing and engraving. For this purpofe he was introduced to the late Mr Richard Cooper at Edinburgh, the only perfon there who had then any tafte in that line of the fine arts. He was bound with him as an apprentice for fix years; during which time he made fuch progrefs in his new profeffion, that his friends entertained the higheft expectation of his fuccefs; nor were they difappointed.

In the year 1747 he married Ifabella, only daughter of William Lumifden, fon of Bifhop Lumifden; and foon after his marriage he went to France, where with the moft ardent application he profecuted his ftudies, chiefly at Paris, under the direction of the celebrated Le Bas, who engraved many excellent prints from the Dutch painters. It was from Le Bas he had the firft hint of the ufe of the inftrument commonly called *the dry needle*; but which he afterwards greatly improved by his own genius, and which has added fuch fuperior beauties to his engravings.

In the year 1751 Mr Strange removed with his family from Edinburgh and fettled at London, where he engraved feveral fine hiftorical prints, which juftly acquired to him great reputation. At this period hiftorical engraving had made little progrefs in Britain, and he may be properly confidered as its father.

The admiration he always had for the works of the great Italian painters made him long defire to vifit Italy, the feat of the fine arts; and the farther he advanced in life, he became the more perfuaded that a journey to that country was effential to an artift who had the laudable ambition to excel in his profeffion. He therefore undertook this journey in the year 1760. In Italy he made many admirable drawings, feveral of which he afterwards engraved. Thefe drawings are now in the poffeffion of Lord Dundas.

Everywhere in Italy fingular marks of attention were beftowed on Mr Strange; not only by great perfonages, but by the principal academies of the fine arts in that country. He was made a member of the academies of Rome, Florence, and Bologna, and profeffor in the royal academy at Parma.

To fhow the eftimation in which his talents were held at Rome, we cannot but record the following anecdote. The ceiling of the room of the Vatican library, in which the collection of engravings is kept, is elegantly painted by Signor Rotfanelli. It reprefents the progrefs of engraving; and the portraits of the moft eminent artifts in that line are there introduced, among which is that of our artift. Under his arm he holds a portfolio, on which his name is infcribed. He is the only Britifh artift on whom this honour has been conferred.

In France, where he refided many years at different periods, his talents likewife received every mark of attention that could be beftowed on a foreigner. He was made a member of the royal academy of painting at Paris.

His majefty King George III. ever attentive to the progrefs of the fine arts in Britain, and fenfible of the advantages of which engraving particularly has been to this

this country, even in a commercial light; and desirous to give a mark of his royal approbation of the merit of Mr Strange, whom he considered as at the head of his profession and the great improver of it—was graciously pleased to confer the honour of knighthood on him the 5th of January 1787.

Such was Sir Robert Strange as an artist; nor was he less distinguished by his truly amiable moral qualities, which endeared him to all who had the happiness to know him.

With regard to his works, he left fifty capital plates, still in good condition, which are carefully preserved in his family. They are engraved from pictures by the most celebrated painters of the Roman, Florentine, Lombard, Venetian, and other schools. They are historical, both sacred and profane, poetical, allegorical.

From his earliest establishment in life, Sir Robert carefully preserved about eighty copies of the finest and most choice impressions of each plate he engraved; which, from length of time, have acquired a beauty, mellowness, and brilliancy, easier seen than described. He did this with a view of presenting them to the public at a period when age should disable him from adding to their number. These he collected into as many volumes, and arranged them in the order in which they were engraved. To each volume he prefixed two portraits of himself, on the same plate, the one an etching, the other a finished proof, from a drawing by John Baptiste Greuse. This is the last plate which he engraved; and is a proof that neither his eyes nor hand were impaired by age. It likewise shows the use he made both of aquafortis and the graver. Each volume, besides a dedication to the king, contains an introduction on the progress of engraving, and critical remarks on the pictures from which his engravings are taken. These volumes were ready to be given to the public, when Sir Robert's death delayed this magnificent publication; a publication which does so much honour to the artist, and to the country which gave him birth. He died at London 5th July 1792.

The following is an authentic catalogue of his works. Plate 1. Two Heads of the author—one an etching, the other a finished proof, from a drawing by John Baptiste Greuse; 2. The Return from Market, by Wouvermans; 3. Cupid, by Vanloo; 4. Mary Magdalen, by Guido; 5. Cleopatra, by the same; 6. The Madonna, by the same; 7. The Angel Gabriel, by the same; 8. The Virgin, holding in her hand a book, and attended by angels, by Carlo Maratt; 9. The Virgin with the Child asleep, by the same; 10. Liberality and Modesty, by Guido; 11. Apollo rewarding Merit and punishing Arrogance, by Andrea Sacchi; 12. The Finding of Romulus and Remus, by Pietro da Cortona; 13. Cæsar repudiating Pompeia, by the same; 14. Three Children of King Charles I. by Vandyke; 15. Belisarius, by Salvator Rosa; 16. St Agnes, by Dominichino; 17 The Judgement of Hercules, by Nicolas Poussin; 18. Venus attired by the Graces, by Guido; 19. and 20. Justice and Meekness, by Raphael; 21. The Offspring of Love, by Guido; 22. Cupid Sleeping, by the same; 23. Abraham giving up the Handmaid Hagar, by Guercino; 24. Esther a Suppliant before Ahasuerus, by the same; 25. Joseph and Potiphar's Wife, by Guido; 26 Venus Blinding Cupid, by Titian; 27. Venus, by the same; 28. Danae, by the same; 29. Portrait of King Charles I. by Vandyke; 30. The Madonna, by Correggio; 31. St Cæcilia, by Raphael; 32. Mary Magdalen, by Guido; 33. Our Saviour appearing to his Mother after his Resurrection, by Guercino; 34. A Mother and Child, by Parmegiano; 35. Cupid Meditating, by Schidoni; 36. Laomedon King of Troy detected by Neptune and Apollo, by Salvator Rosa; 37. The Death of Dido, by Guercino; 38. Venus and Adonis, by Titian; 39. Fortune, by Guido; 40. Cleopatra, by the same; 41. Two Children at School, by Schidoni; 42. Mary Magdalen, by Correggio; 43. Portrait of King Charles I. attended by the marquis of Hamilton, by Vandyke; 44. Queen Henrietta, attended by the Prince of Wales, and holding in her arms the Duke of York, by the same; 45. Apotheosis of the Royal Children, by West; 46. The Annunciation, by Guido; 47. Portrait of Raphael Sancio D'Urbino, by himself; 48. Sappho, by Carlo Dolci; 49. Our Saviour asleep, by Vandyke; 50. St John in the Desert, by Murillo.

STRANGER, in *Law*, denotes a person who is not privy or party to an act. Thus a stranger to a judgement is he to whom a judgement does not belong; in which sense the word stands directly opposed to party or privy.

STRANGLES, in *Farriery*. See that article, N° 481.

STRANGURY, a suppression of urine. See MEDICINE *Index*.

STRAP, among surgeons, a sort of band used to stretch out limbs in the setting of broken or disjointed bones.

STRAP, in a ship, the rope which is spliced about any block, and made with an eye to fasten it anywhere on occasion.

STRAPS, in the manege. The straps of a saddle are small leather straps, nailed to the bows of the saddle, with which we make the girths fast to the saddle.

STRAPADO, or STRAPPADO, a kind of military punishment, wherein the criminals hands being tied behind him, he is hoisted up with a rope to the top of a long piece of wood, and let fall again almost to the ground; so that, by the weight of his body in the shock, his arms are dislocated. Sometimes he is to undergo three strapadoes or more.

STRASBURG, an ancient, large, handsome, and strong city of France, in Alsace, with a population of 40,000. It contains about 200 streets, part of which are very narrow, and most of the houses are built after the ancient taste. However, there are a great number of handsome buildings, such as the hotel of the marshal of France, who is commander of the city; the hotel of the cardinal of Rouen, the bishop's palace, the Jesuits college, the royal hospital, the hotel of Hesse-Darmstadt, the arsenal, the town-house, and the cathedral. It has a wooden bridge over the Rhine, which is thought to be one of the finest in Europe; as is likewise the cathedral church, whose tower is the handsomest in Germany, and the clock is greatly admired by all travellers. Some look upon it as one of the wonders of the world, and the steeple is allowed to be the highest in Europe. The clock not only shows the hours of the day, but the motion of the sun, moon, and stars. Among other things there is an angel, which turns an hour-

hour-glaſs every hour; and the twelve apoſtles proclaim noon, by each of them ſtriking a blow with a hammer on a bell. There is likewiſe a cock, which is a piece of clock-work, that crows every hour. There are 700 ſteps up to the tower or ſteeple, it being 500 feet high. It was a free and imperial city; but the king of France became maſter of it in 1681, and greatly augmented the fortifications, though before it had 365 cannon. The inhabitants were formerly Proteſtants, and carried on a great trade; but moſt of them have been obliged to embrace the Romiſh ſuperſtition, though there is ſtill a ſort of toleration. Such was Straſburg before the French revolution; what it is now we have not leiſure to inquire. It is ſeated on the river Ill, 55 miles north of Baſil, 112 ſouth-weſt of Mentz, and 255 eaſt of Paris. E. Long. 7. 51. N Lat. 48. 35.

STRATA, in *Natural Hiſtory*, the ſeveral beds or layers of different matters whereof the earth is compoſed. See GEOLOGY.

The ſtrata whereof the earth is compoſed are ſo very different in different countries, that it is impoſſible to ſay any thing concerning them that may be generally applicable: and indeed the depths to which we can penetrate are ſo ſmall, that only a very few can be known to us at any rate; thoſe that lie near the centre, or even a great way from it, being for ever hid. One reaſon why we cannot penetrate to any great depth is, that as we go down the air becomes foul, loaded with pernicious vapours, inflammable air, fixed air, &c. which deſtroy the miners, and there is no poſſibility of going on. In many places, however, theſe vapours become pernicious much ſooner than in others, particularly where ſulphureous minerals abound, as in mines of metal, coal, &c.

But however great differences there may be among the under ſtrata, the upper one is in ſome reſpects the ſame all over the globe, at leaſt in this reſpect, that it is fit for the ſupport of vegetables, which the others are not, without long expoſure to the air. Properly ſpeaking, indeed, the upper ſtratum of the earth all round, is compoſed of the pure vegetable mold, though in many places it is mixed with large quantities of other ſtrata, as clay, ſand, gravel, &c.; and hence proceed the differences of ſoils ſo well known to thoſe who practiſe agriculture.

It has been ſuppoſed, by ſome naturaliſts, that the different ſtrata of which the earth is compoſed were originally formed at the creation, and have continued in a manner immutable ever ſince: but this cannot poſſibly have been the caſe, ſince we find that many of the ſtrata are ſtrangely intermixed with each other; the bones of animals both marine and terreſtrial are frequently found at great depths in the earth; beds of oyſter-ſhells are found of immenſe extent in ſeveral countries; and concerning theſe and other ſhell-fiſh, it is remarkable, that they are generally found much farther from the ſurface than the bones or teeth either of marine or terreſtrial animals. Neither are the ſhells or other remains of fiſh found in thoſe countries adjoining to the ſeas where they grow naturally, but in the moſt diſtant regions. Mr Whitehurſt, in his Inquiry into the Original State and Formation of the Earth, has given the following account of many different kinds of animals, whoſe ſhells and other remains or *exuviæ* are found in England; though at preſent the living animals are not to be found except in the Eaſt and Weſt Indies.

A CATALOGUE of EXTRANEOUS FOSSILS, ſhowing where they were dug up; alſo their native Climates. Moſtly ſelected from the curious Cabinet of Mr NEILSON, in King-ſtreet, Red-Lion Square.

Their names, and Places where found.	Native Climates.
CHAMBERED NAUTILUS. Sheppy iſlands; Richmond in Surrey; Sherbone in Dorſetſhire, -	*Chineſe Ocean, and other Parts of that great ſea.*
TEETH OF SHARKS. Sheppy iſland, Oxfordſhire, Middleſex, Surrey, Northamptonſhire, -	*Eaſt and Weſt Indies.*
SEA-TORTOISE, ſeveral kinds; the *Hawkſbill, Loggerhead, and Green* ſpecies. Sheppy iſland, -	*Weſt Indies.*
MANGROVE TREE OYSTERS. Sheppy iſland, - - - -	*Weſt Indies.*
COXCOMB TREE OYSTERS. Oxfordſhire, Glouceſterſhire, Dorſetſhire, and Hanover, -	*Coaſt of Guinea.*
VERTEBRÆ *and* PALATES *of the* ORBES. Sheppy iſland, and many other parts of England, -	*Eaſt and Weſt Indies.*
CROCODILE. Germany, Derbyſhire, Nottinghamſhire, Oxfordſhire, and Yorkſhire, -	
ALLIGATOR'S TEETH. Oxfordſhire, Sheppy iſland, -	*Eaſt and Weſt Indies.*
The BANDED BUCCINUM. Oxfordſhire, and the Alps, -	*Weſt Indies.*
The DIPPING-SNAIL, and STAR-FISH. Sheppy iſland, -	*Weſt Indies.*
TAIL BUCCINUM. Sheppy iſland, Hordel Cliff, Hampſhire, -	*Eaſt Indies.*

Nothing has more perplexed thoſe who undertake to form theories of the earth than theſe appearances. Some have at once boldly aſſerted, from theſe and other phenomena, that the world is eternal. Others have had recourſe to the univerſal deluge. Some, among whom is the Count de Buffon, endeavour to prove that the ocean and dry land are perpetually changing places; that for many ages the higheſt mountains have been covered with water, in conſequence of which the marine animals juſt mentioned were generated in ſuch vaſt quantities, that the waters will again cover theſe mountains. the habitable part of the earth become ſea, and the ſea become dry land as before, &c. Others have imagined that they might be occaſioned by volcanoes, earthquakes, &c. which confound the different ſtrata, and often intermix the productions of the ſea with thoſe of the dry land.

But for a view of the different ſtrata ſo far as they are known; as well as for a view of ſome of the theories which have been propoſed to account for the formation and changes of the earth, ſee GEOLOGY.

Mr Forſter has given an account of ſome of the ſtrata of the South-ſea iſlands, the ſubſtance of which may be ſeen in the following table.

SOUTH GEORGIA.

1. No ſoil, except in a few crevices of the rocks.

Strata.

2. Ponderous ſlate, with ſome irony particles, in horizontal ſtrata, perpendicularly interſected with veins of quartz.

Southern Iſle of New Zealand.

1. Fine light black mould, in ſome places nine inches deep, but generally not ſo much.
2. An argillaceous ſubſtance, nearly related to the claſs of Talcons, turned into earth by the action of the air.
3. The ſame ſubſtance farther indurated, in oblique ſtrata, generally dipping to the ſouth.

Easter Island.

1. Reddiſh-brown duſty mould, looking as if it had been burnt.
2. Burnt rocks, reſembling ſlags or droſs and other volcanic matters.

Marquesas.

1. Clay mixed with mould.
2. An earthy argillaceous ſubſtance mixed with tarras and puzzolana.

Otaheite.

The ſhores are coral rock, extending from the reef encircling theſe iſles to the very high water-mark. There begins the ſand, formed in ſome places from ſmall ſhells and rubbed pieces of coral; but in others the ſhores are covered with blackiſh ſand, conſiſting of the former ſort mixed with black, ſometimes glittering, particles of mica, and here and there ſome particles of the refractory iron ores called in England Skim, the *ferrum micaceum* of Linnæus, and Kall, the *molybdænum ſpuma lupi* of the ſame author. The plains from the ſhores to the foot of the hills are covered with a very fine thick ſtratum of black mould, mixed with the above-mentioned ſand, which the natives manure with ſhells. The firſt and lower range of hills are formed of a red ochreous earth, ſometimes ſo intenſely red, that the natives uſe it to paint their canoes and cloth. The higher hills conſiſt of a hard, compact, and ſtiff clayey ſubſtance, hardening into ſtone when out of the reach of the ſun and air. At the top of the valleys, along the banks of the rivers, are large maſſes of coarſe granite ſtones of various mixtures; in one place are pillars of a grey, ſolid baſaltes; and, in ſeveral others, fragments of black baſaltes.

Friendly Islands and New Hebrides.

The ſame with the above.

Mallicollo.

Yellowiſh clay mixed with common ſand.

Tanna, *a Volcanic Iſland.*

The chief ſtrata here are clay mixed with aluminous earth, interſperſed with lumps of pure chalk. The ſtrata of the clay are about ſix inches, deviating very little from the horizontal line.

New Caledonia and the *adjacent Iſles.*

The ſhores conſiſt of ſhell-ſand, and particles of quartz; the ſoil in the plains a black mould mixed with this ſand. The ſides of the hills compoſed of a yellow ochreous clay, richly ſpangled with ſmall particles of cat-ſilver, or a whitiſh kind of daze, the *mica argentea* of Linnæus. The higher parts of the hills conſiſt of a ſtone called by the German miners *geſtelſtein*, compoſed of quartz and great lumps of the above cat-ſilver. The latter is ſometimes of an intenſely red or orange colour, by means of an iron ochre.

" From the above account, ſays Mr Forſter, it appears, I think, evidently, that all the high tropical iſles of the South ſea have been ſubject to the action of volcanoes. Pyritical and ſulphureous ſubſtances, together with a few iron-ſtones, and ſome veſtiges of copper, are no doubt found in ſeveral of them: but the mountains of New Caledonia are the moſt likely to contain the richeſt metallic veins; and the ſame opinion, I ſuſpect, may be formed of the mountains in New Zealand."

In the city of Modena in Italy, and for ſome miles round that place, there is the moſt ſingular arrangement of ſtrata perhaps in the whole world. From the ſurface of the ground to the depth of 14 feet, they meet with nothing but the ruins of an ancient city. Being come to that depth, they find paved ſtreets, artificers ſhops, floors of houſes, and ſeveral pieces of inlaid work. After theſe ruins they find a very ſolid earth, which one would think had never been removed; but a little lower they find it black and marſhy, and full of briars. Signior Ramazzini in one place found a heap of wheat entire at the depth of 24 feet; in another, he found filbert-trees with their nuts. At the depth of about 28 feet, they find a bed of chalk, about 11 feet deep, which cuts very eaſily; after this a bed of marſhy earth of about two feet, mixed with ruſhes, leaves, and branches. After this bed comes another of chalk, nearly of the ſame thickneſs; and which ends at the depth of 42 feet. This is followed by another bed of marſhy earth like the former; after which comes a new chalk-bed, but thinner, which alſo has a marſhy bed underneath it. This ends at the depth of 63 feet; after which they find ſand mingled with ſmall gravel, and ſeveral marine ſhells. This ſtratum is uſually about five feet deep, and underneath it is a vaſt reſervoir of water. It is on account of this water that the ſoil is ſo frequently dug, and the ſtrata ſo well known in this part of the world. After coming to the ſandy bottom above-mentioned, the workmen pierce the ground with a terebra or augre, when the water immediately ſprings up with great force, and fills the well to the brim. The flow is perpetual, and neither increaſes by rain. nor decreaſes by drought. Sometimes the augre meets with great trees, which give the workmen much trouble; they alſo ſometimes ſee at the bottom of theſe wells great bones, coals, flints, and pieces of iron.

It has been aſſerted by ſome, that the ſpecific gravity of the ſtrata conſtantly increaſed with the depth from the ſurface. But Dr Leigh, in his Natural Hiſtory of Lancaſhire, ſpeaking of the coal-pits, denies the ſtrata to lie according to the laws of gravitation; obſerving, that the ſtrata there are firſt a bed of marle, then free-ſtone, next iron-ſtone, then coal, or channel mire, then ſome other ſtrata, then coal again, &c. This determined Mr Derham to make a nicer inquiry into the matter: accordingly, in 1712, he cauſed divers places to be bored, laying the ſeveral ſtrata by themſelves; and afterwards determined very carefully their ſpecific gravity. The reſult was, that in his yard the ſtrata were gradually ſpecifically heavier and heavier the lower and lower they went; but in another place in his fields, he could not perceive any difference in the ſpecific gravities.

Acquainting the Royal Society therewith, their operator Mr Haukſbee was ordered to try the ſtrata of a coal pit, which he did to the depth of 30 ſtrata: the thickneſs and ſpecific gravity of each whereof he gives us in a table in the Philoſophical Tranſactions; and from the whole makes this inference, that it evidently appears the gravities of the ſeveral ſtrata are in no manner of order, but purely caſual, as if mixed by chance.

Vol. xxvii. p. 541.

STRATAGEM, in the art of war, any device for deceiving and ſurpriſing an enemy. The ancients dealt very much in ſtratagems: the moderns wage war more openly, and on the ſquare. Frontinus has made a collection of the ancient ſtratagems of war.

STRATEGUS, ϛϱατηγος, in antiquity, an officer among the Athenians, whereof there were two choſen yearly, to command the troops of the ſtate.

Plutarch ſays, there was one choſen from out of each tribe; but Pollux ſeems to ſay they were choſen indifferently out of the people. The people themſelves made the choice; and that on the laſt day of the year, in a place called *Pnyx*. The two *ſtrategi* did not command together, but took their turns day by day; as we find from Herodotus and Cornelius Nepos. Sometimes indeed, as when a perſon was found of merit vaſtly ſuperior, and exceedingly famed in war, the command was given to him alone: but it was ever a rule not to put any perſon in the office but whoſe eſtate was in Attica, and who had children, that there might be ſome hoſtages and ſecurities for his conduct and fidelity. Conſtantine the Great, beſides many other privileges granted to the city of Athens, honoured its chief magiſtrate with the title of Μεγας Στρατηγος, *Magnus Dux*.

STRATH, in the Scottiſh language, ſignifies a long narrow valley, with a river running along the bottom.

STRATHEARN, a beautiful and extenſive valley in Perthſhire, bounded on the north by the lofty ridge of mountains called the *Grampians*, and on the ſouth by the Ochils, which are rounded on the tops and covered with verdure. It is called *Strathearn* from the river Earn, which runs through the middle of it from weſt to eaſt for about 30 miles. On each ſide of the banks of this beautiful ſtream are many villages and country-ſeats diſtinguiſhed for romantic ſituations. Were we to ſingle out any of the villages, we would mention Crieff, which ſtands on a fine ſloping ground on the north ſide of the Earn, and has been much admired by travellers for its ſituation, and the variety, contraſt, ſingularity, and beauty of the proſpect which it affords.

STRATHNAVER, a ſubdiviſion or diſtrict of the county of Sutherland in Scotland; bounded on the north by the ocean, on the eaſt by Caithneſs, on the ſouth by Sutherland properly ſo called, and on the weſt partly by Roſs and partly by the ocean.

STRATIOTES, WATER-SOLDIER, a genus of plants belonging to the claſs polyandria. See BOTANY *Index*.

STRATO, a philoſopher of Lampſacus, diſciple and ſucceſſor in the ſchool of Theophraſtus, about 248 years before the Chriſtian era. He applied himſelf with uncommon induſtry to the ſtudy of nature; and after the moſt mature inveſtigations, he ſupported that nature was inanimate, and that there was no god but nature. (See *PLASTIC Nature*). He was appointed preceptor to Ptolemy Philadelphus, who not only revered his abilities and learning, but alſo rewarded his labours with unbounded liberality. He wrote different treatiſes, all now loſt.

STRAWBERRY. See FRAGARIA, BOTANY *Index*.

STRAWBERRY-Tree. See ARBUTUS, BOTANY *Index*.

STRENGTH OF MATERIALS, in *Mechanics*, is a ſubject of ſo much importance, that in a nation ſo eminent as this for invention and ingenuity in all ſpecies of manufactures, and in particular ſo diſtinguiſhed for its improvements in machinery of every kind, it is ſomewhat ſingular that no writer has treated it in the detail which its importance and difficulty demands. The man of ſcience who viſits our great manufactories is delighted with the ingenuity which he obſerves in every part, the innumerable inventions which come even from individual artiſans, and the determined purpoſe of improvement and refinement which he ſees in every workſhop. Every cotton mill appears an academy of mechanical ſcience; and mechanical invention is ſpreading from theſe fountains over the whole kingdom: But the philoſopher is mortified to ſee this ardent ſpirit ſo cramped by ignorance of principle, and many of theſe original and brilliant thoughts obſcured and clogged with needleſs and even hurtful additions, and a complication of machinery which checks improvement even by its appearance of ingenuity. There is nothing in which this want of ſcientific education, this ignorance of principle, is ſo frequently obſerved as in the injudicious proportion of the parts of machines and other mechanical ſtructures; proportions and forms of parts in which the ſtrength and poſition are nowiſe regulated by the ſtrains to which they are expoſed, and where repeated failures have been the only leſſons.

1 Importance of the ſubject.

It cannot be otherwiſe. We have no means of inſtruction, except two very ſhort and abſtracted treatiſes of the late Mr Emerſon on the ſtrength of materials. We do not recollect a performance in our language from which our artiſts can get information. Treatiſes written expreſsly on different branches of mechanical arts are totally ſilent on this, which is the baſis and *only principle* of their performances. Who would imagine that PRICE'S BRITISH CARPENTER, the work of the firſt reputation in this country, and of which the ſole aim is to teach the carpenter to erect ſolid and durable ſtructures, does not contain one propoſition or one reaſon by which one form of a thing can be ſhown to be ſtronger or weaker than another? We doubt very much if one carpenter in an hundred can give a reaſon to convince his own mind that a joiſt is ſtronger when laid on its edge than when laid on its broad ſide. We ſpeak in this ſtrong manner in hopes of exciting ſome man of ſcience to publiſh a ſyſtem of inſtruction on this ſubject. The limits of our Work will not admit of a detail: but we think it neceſſary to point out the leading principles, and to give the traces of that ſyſtematic connection by which all the knowledge already poſſeſſed of this ſubject may be brought

brought together and properly arranged. This we ſhall now attempt in as brief a manner as we are able.

2 Strength of materials ariſes from coheſion.

THE ſtrength of materials ariſes immediately or ultimately from the coheſion of the parts of bodies. Our examination of this property of tangible matter has as yet been very partial and imperfect, and by no means enables us to apply mathematical calculations with preciſion and ſucceſs. The various modifications of coheſion, in its different appearances of perfect ſoftneſs, plaſticity, ductility, elaſticity, hardneſs, have a mighty influence on the ſtrength of bodies, but are hardly ſuſceptible of meaſurement. Their texture alſo, whether uniform like glaſs and ductile metals, cryſtallized or granulated like other metals and freeſtone, or fibrous like timber, is a circumſtance no leſs important; yet even here, although we derive ſome advantage from remarking to which of theſe forms of aggregation a ſubſtance belongs, the aid is but ſmall. All we can do in this want of general principles is to make experiments on every claſs of bodies. Accordingly philoſophers have endeavoured to inſtruct the public in this particular. The Royal Society of London at its very firſt inſtitution made many experiments at their meetings, as may be ſeen in the firſt regiſters of the Society *. Several individuals have added their experiments. The moſt numerous collection in detail is by Muſchenbroek, profeſſor of natural philoſophy at Leyden. Part of it was publiſhed by himſelf in his *Eſſais de Phyſique*, in two vols. 4to; but the full collection is to be found in his Syſtem of Natural Philoſophy, publiſhed after his death by Lulofs, in three vols 4to. This was tranſlated from the Low Dutch into French by Sigaud de la Fond, and publiſhed at Paris in 1760, and is a prodigious collection of phyſical knowledge of all kinds, and may almoſt ſuffice for a library of natural philoſophy. But this collection of experiments on the coheſion of bodies is not of that value which one expects. We preſume that they were carefully made and faithfully narrated; but they were made on ſuch ſmall ſpecimens, that the unavoidable natural inequalities of growth or texture produced irregularities in the reſults which bore too great a proportion to the whole quantities obſerved. We may make the ſame remark on the experiments of Couplet, Pitot, De la Hire, Du Hamel, and others of the French academy. In ſhort, if we except the experiments of Buffon on the ſtrength of timber, made at the public expence on a large ſcale, there is nothing to be met with from which we can obtain abſolute meaſures which may be employed with confidence; and there is nothing in the Engliſh language except a ſimple liſt by Emerſon, which is merely a ſet of affirmations, without any narration of circumſtances, to enable us to judge of the validity of his concluſions: but the character of Mr Emerſon, as a man of knowledge and of integrity, gives even to theſe aſſertions a conſiderable value.

3 Experiments to aſcertain it.

* See Birche's *Hiſtory*, and Hooke's *Mathematical Collections*.

4 Rendered uſeful by generalization.

But to make uſe of any experiments, there muſt be employed ſome general principle by which we can generalize their reſults. They will otherwiſe be only narrations of detached facts. We muſt have ſome notion of that intermedium, by the intervention of which an external force applied to one part of a lever, joiſt, or pillar, occaſions a ſtrain on a diſtant part. This can be nothing but the coheſion between the parts. It is this connecting force which is brought into action, or, as we more ſhortly expreſs it, excited. This action is modified in every part by the laws of mechanics. It is this action which is what we call the *ſtrength* of that part, and its effect is the ſtrain on the adjoining parts; and thus it is the ſame force, differently viewed, that conſtitutes both the ſtrain and the ſtrength. When we conſider it in the light of a reſiſtance to fracture, we call it *ſtrength*.

5 Strength defined.

We call every thing a *force* which we obſerve to be ever accompanied by a change of motion; or, more ſtrictly ſpeaking, we infer the preſence and agency of a force wherever we obſerve the ſtate of things in reſpect of motion different from what we know to be the reſult of the action of all the forces which we know to act on the body. Thus when we obſerve a rope prevent a body from falling, we infer a moving force inherent in the rope with as much confidence as when we obſerve it drag the body along the ground. The *immediate action* of this force is undoubtedly exerted between the immediately adjoining parts of the rope. The immediate effect is the keeping the particles of the rope together. They ought to ſeparate by any external force drawing the ends of the rope contrarywiſe; and we aſcribe their not doing ſo to a mechanical force really oppoſing this external force. When deſired to give it a name, we name it from what we conceive to be its effect, and therefore its characteriſtic, and we call it COHESION. This is merely a name for the fact; but it is the ſame thing in all our denominations. We know nothing of the cauſes but in the effects; and our name for the cauſe is in fact the name of the effect, which is COHESION. We mean nothing elſe by gravitation or magnetiſm. What do we mean when we ſay that Newton underſtood thoroughly the nature of gravitation, of the force of gravitation; or that Franklin underſtood the nature of the electric force? Nothing but this: Newton conſidered with patient ſagacity the general facts of gravitation, and has deſcribed and claſſed them with the utmoſt preciſion. In like manner, we ſhall underſtand the nature of coheſion when we have diſcovered with equal generality the laws of coheſion, or general facts which are obſerved in the appearances, and when we have deſcribed and claſſed them with equal accuracy.

6 Cauſes known only from their effects.

Let us therefore attend to the more ſimple and obvious phenomena of coheſion, and mark with care every circumſtance of reſemblance by which they may be claſſed. Let us receive theſe as the laws of coheſion, characteriſtic of its ſuppoſed cauſe, the force of coheſion. We cannot pretend to enter on this vaſt reſearch. The modifications are innumerable: and it would require the penetration of more than Newton to detect the circumſtance of ſimilarity amidſt millions of diſcriminating circumſtances. Yet this is the only way of diſcovering which are the primary facts characteriſtic of the force, and which are the modifications. The ſtudy is immenſe, but it is by no means deſperate; and we entertain great hopes that it will ere long be ſucceſsfully proſecuted: but, in our particular predicament, we muſt content ourſelves with ſelecting ſuch general laws as ſeem to give us the moſt immediate information of the circumſtances that muſt be attended to by the mechanician in his conſtructions, that he may unite ſtrength with ſimplicity, economy, and energy.

1. Then, it is a matter of fact that all bodies are in a

certain degree perfectly elaftic; that is, when their form or bulk is changed by certain moderate compreffions or diftractions, it requires the continuance of the changing force to continue the body in this new ftate; and when the force is removed, the body recovers its original form. We limit the affertion to *certain moderate* changes: For inftance, take a lead wire of one-fifteenth of an inch in diameter and ten feet long; fix one end firmly to the ceiling, and let the wire hang perpendicular; affix to the lower end an index like the hand of a watch; on fome ftand immediately below let there be a circle divided into degrees, with its centre correfponding to the lower point of the wire: now turn this index twice round, and thus twift the wire. When the index is let go, it will turn backwards again, by the wire's untwifting itfelf, and make almoft four revolutions before it ftops; after which it twifts and untwifts many times, the index going backwards and forwards round the circle, diminifhing however its arch of twift each time, till at laft it fettles precifely in its original pofition. This may be repeated for ever. Now, in this motion, every part of the wire partakes equally of the twift. The particles are ftretched, require force to keep them in their ftate of extenfion, and recover completely their relative pofitions. Thefe are all the characters of what the mechanician calls *perfect* elafticity. This is a quality quite familiar in many cafes; as in glafs, tempered fteel, &c. but was thought incompetent to lead, which is generally confidered as having little or no elafticity. But we make the affertion in the moft general terms, with the limitation to moderate derangement of form. We have made the fame experiment on a thread of pipe-clay, made by forcing foft clay through the fmall hole of a fyringe by means of a fcrew; and we found it more elaftic than the lead wire: for a thread of one-twentieth of an inch diameter and feven feet long allowed the index to make two turns, and yet completely recovered its firft pofition.

7 All bodies elaftic.

2. But if we turn the index of the lead wire four times round, and let it go again, it untwifts again in the fame manner, but it makes little more than four turns back again; and after many ofcillations it finally ftops in a pofition almoft two revolutions removed from its original pofition. It has now acquired a new arrangement of parts, and this new arrangement is permanent like the former; and, what is of particular moment, it is perfectly elaftic. This change is familiarly known by the denomination of a SET. The wire is faid to have TAKEN A SET. When we attend minutely to the procedure of nature in this phenomenon, we find that the particles have as it were flid on each other, ftill cohering, and have taken a new pofition, in which their connecting forces are in equilibrio: and in this change of relative fituation, it appears that the connecting forces which maintained the particles in their firft fituation were not in equilibrio in fome pofition intermediate between that of the firft and that of the laft form. The force required for changing this firft form augmented with the change, but only to a certain degree; and during this procefs the connecting forces always tended to the recovery of this firft form. But after the change of mutual pofition has paffed a certain magnitude, the union has been partly deftroyed, and the particles have been brought into new fituations; fuch, that the forces which now connect each with its neighbour tend, not to the recovery of the firft arrangement, but to pufh them farther from it, into a new fituation, to which they now verge, and require force to prevent them from acquiring. The wire is now in fact again perfectly elaftic; that is, the forces which now connect the particles with their neighbours augment to a certain degree as the derangement from this new pofition augments. This is not reafoning from any theory. It is narrating facts, on which a theory is to be founded. What we have been juft now faying is evidently a defcription of that fenfible form of tangible matter which we call *ductility*. It has every gradation of variety, from the foftnefs of butter to the firmnefs of gold. All thefe bodies have fome elafticity; but we fay they are not perfectly elaftic, becaufe they do not completely recover their original form when it has been greatly damaged. The whole gradation may be moft diftinctly obferved in a piece of glafs or hard fealing wax. In the ordinary form glafs is perhaps the moft completely elaftic body that we know, and may be bent till juft ready to fnap, and yet completely recovers its firft form, and takes no fet whatever; but when heated to fuch a degree as juft to be vifible in the dark, it lofes its brittlenefs, and becomes fo tough that it cannot be broken by any blow; but it is no longer elaftic, takes any fet, and keeps it. When more heated, it becomes as plaftic as clay; but in this ftate is remarkably diftinguifhed from clay by a quality which we may call VISCIDITY, which is fomething like elafticity, of which clay and other bodies purely plaftic exhibit no appearance. This is the joint operation of ftrong adhefion and foftnefs. When a rod of perfectly foft glafs is fuddenly ftretched a little, it does not at once take the fhape which it acquires after fome little time. It is owing to this, that in taking the impreffion of a feal, if we take off the feal while the wax is yet very hot, the fharpnefs of the impreffion is deftroyed immediately. Each part drawing its neighbour, and each part yielding, the prominent parts are pulled down and blunted, and the fharp hollows are pulled upwards and alfo blunted. The feal muft be kept on till all has become not only ftiff but hard.

8 What is meant by a *fet*.

9 Ductility.

10 Vifcidity.

This vifcidity is to be obferved in all plaftic bodies which are homogeneous. It is not obferved in clay, becaufe it is not homogeneous, but confifts of hard particles of argillaceous earth fticking together by their attraction for water. Something like it might be made of finely powdered glafs and a clammy fluid fuch as turpentine. Vifcidity has all degrees of foftnefs till it degenerates to ropy fluidity like that of olive oil. Perhaps fomething of it may be found even in the moft perfect fluid that we are acquainted with, as we obferved in the experiments for afcertaining fpecific gravity.

11 Obferved in all homogeneous plaftic bodies.

There is in a late volume of the Philofophical Tranfactions a narrative of experiments, by which it appears that the thread of the fpider is an exception to our firft general law, and that it is perfectly ductile. It is there afferted, that a long thread of goffamer, furnifhed with an index, takes any pofition whatever; and that though the index be turned round any number of times (even many hundreds), it has no tendency to recover its firft form. The thread takes completely any fet whatever. We have not had an opportunity of repeating this experiment, but we have diftinctly obferved a phenomenon totally inconfiftent with it. If a fibre of goffamer about an inch long be held by the end horizontally, it bends downward

downward in a curve like a ſlender ſlip of whalebone or a hair. If totally devoid of elaſticity, and perfectly indifferent to any ſet, it would hang down perpendicularly without any curvature.

When ductility and elaſticity are combined in different proportions, an immenſe variety of ſenſible modes of aggregation may be produced. Some degree of both are probably to be obſerved in all bodies of complex conſtitution; that is, which conſiſt of particles made up of many different kinds of atoms. Such a conſtitution of a body muſt afford many ſituations permanent, but eaſily deranged.

In all theſe changes of diſpoſition which take place among the particles of a ductile body, the particles are at ſuch diſtance that they ſtill cohere. The body may be ſtretched a little; and on removing the extending force, the body ſhrinks into its firſt form. It alſo re-
12 Particles acted on by attractions and repulſions
ſiſts moderate compreſſions; and when the compreſſing force is removed, the body ſwells out again. Now the corpuſcular *fact* here is, that the particles are acted on by attractions and repulſions, which balance each other when no external force is acting on the body, and which augment as the particles are made, by any external cauſe, to recede from this ſituation of mutual inactivity; for ſince force is requiſite to produce either the dilatation or the compreſſion, and to maintain it, we are obliged, by the conſtitution of our minds, to infer that it is oppoſed by a force accompanying or inherent in every particle of dilatable or compreſſible matter; and as this neceſſity of employing force to produce a change indicates the agency of theſe corpuſcular forces, and marks their kind, according as the tendencies of the particles appear to be toward each other in dilatation, or from each other in compreſſion; ſo it alſo meaſures the degrees of their intenſity. Should it require three times the force to produce a double compreſſion, we muſt reckon the mutual repulſions triple when the compreſſion is doubled; and ſo in other inſtances. We ſee from all
13 The great problem in corpuſcular mechaniſm.
this that the phenomena of coheſion indicate ſome relation between the centres of the particles. To diſcover this relation is the great problem in corpuſcular mechaniſm, as it was in the Newtonian inveſtigation of the force of gravitation. Could we diſcover this law of action between the corpuſcles with the ſame certainty and diſtinctneſs, we might with equal confidence ſay what will be the reſult of any poſition which we give to the particles of bodies; but this is beyond our hopes. The law of gravitation is ſo ſimple, that the diſcovery or detection of it amid the variety of celeſtial phenomena required but one ſtep; and in its own nature its poſſible combinations ſtill do not greatly exceed the powers of human reſearch. One is almoſt diſpoſed to ſay that the Supreme Being has exhibited it to our reaſoning powers as ſufficient to employ with ſucceſs our utmoſt efforts, but not ſo abſtruſe as to diſcourage us from the noble attempt. It ſeems to be otherwiſe with reſpect to coheſion. Mathematics informs us, that if it deviates ſenſibly from the law of gravitation, the ſimpleſt combinations will make the joint action of ſeveral particles an almoſt impenetrable myſtery. We muſt therefore content ourſelves, for a long time to come, with a careful obſervation of the ſimpleſt caſes that we can propoſe, and with the diſcovery of ſecondary laws of action, in which many particles combine their influence. In purſuance of this plan, we obſerve,

3. That whatever is the ſituation of the particles of a body with reſpect to each other, when in a quieſcent ſtate, they are kept in theſe ſituations by the balance of oppoſite forces. This cannot be refuſed, nor can we
14 Particles kept in their places by a balance of forces.
form to ourſelves any other notion of the ſtate of the particles of a body. Whether we ſuppoſe the ultimate particles to be of certain magnitudes and ſhapes, touching each other in ſingle points of coheſion; or whether we (with Boſcovich) conſider them as at a diſtance from each other, and acting on each other by attractions and repulſions—we muſt acknowledge, in the firſt place, that the centres of the particles (by whoſe mutual diſtances we muſt eſtimate the diſtance of the particles) may and do vary their diſtances from each other. What elſe can we ſay when we obſerve a body increaſe in length, in breadth, and in thickneſs, by heating it, or when we ſee it diminiſh in all theſe dimenſions by an external compreſſion? A particle, therefore, ſituated in the midſt of many others, and remaining in that ſituation, muſt be conceived as maintained in it by the mutual balancing of all the forces which connect it with its neighbours. It is like a ball kept in its place by the
15 Illuſtration of this propoſition.
oppoſite action of two ſprings. This illuſtration merits a more particular application. Suppoſe a number of balls ranged on the table in the angles of equilateral triangles, and that each ball is connected with the ſix which lie around it by means of an elaſtic wire curled like a cork-ſcrew; ſuppoſe ſuch another ſtratum of balls above this, and parallel to it, and ſo placed that each ball of the upper ſtratum is perpendicularly over the centre of the equilateral triangle below, and let theſe be connected with the balls of the under ſtratum by ſimilar ſpiral wires. Let there be a third and a fourth, and any number of ſuch ſtrata, all connected in the ſame manner. It is plain that this may extend to any ſize and fill any ſpace.—Now let this aſſemblage of balls be firmly contemplated by the imagination, and be ſuppoſed to ſhrink continually in all its dimenſions, till the balls, and their diſtances from each other, and the connecting wires, all vaniſh from the ſight as diſcrete individual objects. All this is very conceivable. It will now appear like a ſolid body, having length, breadth, and thickneſs; it may be compreſſed, and will again reſume its dimenſions; it may be ſtretched, and will again ſhrink; it will move away when ſtruck; in ſhort, it will not differ in its ſenſible appearance from a ſolid elaſtic body. Now when this body is in a ſtate of compreſſion, for inſtance, it is evident that any one of the balls is at reſt, in conſequence of the mutual balancing of the actions of all the ſpiral wires which connect it with thoſe around it. It will greatly conduce to the full underſtanding of all that follows to recur to this illuſtration. The analogy or reſemblance between the effects of this conſtitution of things and the effects of the corpuſcular forces is very great; and wherever it obtains, we may ſafely draw concluſions from what we know would be the condition of a body of common tangible matter. We ſhall juſt give
16 By example.
one inſtructive example, and then have done with this hypothetical body. We can ſuppoſe it of a long ſhape, reſting on one point; we can ſuppoſe two weights A, B, ſuſpended at the extremities, and the whole in equilibrio. We commonly expreſs this ſtate of things by ſaying that A and B are in equilibrio. This is very inaccurate. A is in fact in equilibrio with the united action of all the ſprings which connect the ball to which it is applied with

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with the adjoining balls. Theſe ſprings are brought into action, and each is in equilibrio with the joint action of all the reſt. Thus through the whole extent of the hypothetical body, the ſprings are brought into action in a way and in a degree which mathematics can eaſily inveſtigate. We need not do this: it is enough for our purpoſe that our imagination readily diſcovers that ſome ſprings are ſtretched, others are compreſſed, and that a preſſure is excited on the middle point of ſupport, and the ſupport exerts a reaction which preciſely balances it; and the other weight is, in like manner, in immediate equilibrio with the equivalent of the actions of all the ſprings which connect the laſt ball with its neighbours. Now take the analogical or reſembling caſe, an oblong piece of ſolid matter, reſting on a fulcrum, and loaded with two weights in equilibrio. For the actions of the connecting ſprings ſubſtitute the corpuſcular forces, and the reſult will reſemble that of the hypotheſis.

Now as there is ſomething that is at leaſt analogous to a change of diſtance of the particles, and a concomitant change of the intenſity of the connecting forces, we may expreſs this in the ſame way that we are accuſtomed to do in ſimilar caſes. Let A and B (fig. 1.) repreſent the centres of two particles of a coherent elaſtic body in their quieſcent inactive ſtate, and let us conſider only the mechanical condition of B. The body may be ſtretched. In this caſe the diſtance A B of the particles may become A C. In this ſtate there is ſomething which makes it neceſſary to employ a force to keep the particles at this diſtance. C has a tendency towards A, or we may ſay that A attracts C. We may repreſent the magnitude of this tendency of C *towards* A, or this attraction of A, by a line C *c* perpendicular to A C. Again, the body may be compreſſed, and the diſtance A B may become A D. Something obliges us to employ force to continue this compreſſion; and D tends *from* A, or A appears to *repel* D. The intenſity of this tendency or repulſion may be repreſented by another perpendicular D *d*; and, to repreſent the different directions of theſe tendencies, or the different nature of theſe actions, we may ſet D *d* on the oppoſite ſide of A B. It is in this manner that the Abbé Boſcovich has repreſented the actions of corpuſcular forces in his celebrated Theory of Natural Philoſophy. Newton had ſaid, that, as the great movements of the ſolar ſyſtem were regulated by forces operating at a diſtance, and varying with the diſtance, ſo he ſtrongly ſuſpected (*valde ſuſpicor*) that all the phenomena of coheſion, with all its modifications in the different ſenſible forms of aggregation, and in the phenomena of chemiſtry and phyſiology, reſulted from the ſimilar agency of forces varying with the diſtance of the particles. The learned Jeſuit purſued this thought; and has ſhown, that if we ſuppoſe an ultimate atom of matter endowed with powers of attraction and repulſion, varying, both in kind and degree, with the diſtance, and if this force be the ſame in every atom, it may be regulated by ſuch a relation to the diſtance from the neighbouring atom, that a collection of ſuch may have all the ſenſible appearance of bodies in their different forms of ſolids, liquids, and vapours, elaſtic or unelaſtic, and endowed with all the properties which we perceive, by whoſe immediate operation the phenomena of motion by impulſe, and all the phenomena of chemiſtry, and of animal and vegetable economy, may be produced. He ſhows, that notwithſtanding a perfect ſameneſs, and even a great ſimplicity in this atomical conſtitution, there will reſult from this union all that unſpeakable variety of form and property which diverſify and embelliſh the face of nature. We ſhall take another opportunity of giving ſuch an account of this celebrated work as it deſerves. We mention it only, by the bye, as far as a general notion of it will be of ſome ſervice on the preſent occaſion. For this purpoſe, we juſt obſerve that Boſcovich conceives a particle of any individual ſpecies of matter to conſiſt of an unknown number of particles of ſimpler conſtitution; each of which particles, in their turn, is compounded of particles ſtill more ſimply conſtituted, and ſo on through an unknown number of orders, till we arrive at the ſimpleſt poſſible conſtitution of a particle of tangible matter, ſuſceptible of length, breadth, and thickneſs, and neceſſarily conſiſting of four atoms of matter. And he ſhows that the more complex we ſuppoſe the conſtitution of a particle, the more muſt the ſenſible qualities of the aggregate reſemble the obſerved qualities of tangible bodies. In particular, he ſhows how a particle may be ſo conſtituted, that although it act on one other particle of the ſame kind through a conſiderable interval, the interpoſition of a third particle of the ſame kind may render it totally, or almoſt totally, inactive; and therefore an aſſemblage of ſuch particles would form ſuch a fluid as air. All theſe curious inferences are made with uncontrovertible evidence; and the greateſt encouragement is thus given to the mathematical philoſopher to hope, that by cautious and patient proceeding in this way, we may gradually approach to a knowledge of the laws of coheſion, that will not ſhun a compariſon even with the *Principia* of Newton. No ſtep can be made in this inveſtigation, but by obſerving with care, and generalizing with judgement, the phenomena, which are abundantly numerous, and much more at our command than thoſe of the great and ſenſible motions of bodies. Following this plan, we obſerve, 18

Plate DXI. Fig. 1.

17 How Boſcovich repreſents the action of corpuſcular forces.

Every body compreſſible and dilatable.

4. It is matter of fact, that every body has ſome degree of compreſſibility and dilatability; and when the changes of dimenſion are ſo moderate that the body completely recovers its original dimenſions on the ceſſation of the changing force, the extenſions or compreſſions are ſenſibly proportional to the extending or compreſſing forces: and therefore *the connecting forces are proportional to the diſtances of the particles from their quieſcent, neutral, or inactive poſitions*. This ſeems to have been firſt viewed as a law of nature by the penetrating eye of Dr Robert Hooke, one of the moſt eminent philoſophers of the laſt century. He publiſhed a cipher, which he ſaid contained the theory of ſpringineſs and of the motions of bodies by the action of ſprings. It was this, *c e i i i n o s s s t t u u*.—When explained in his diſſertation, publiſhed ſome years after, it was *ut tenſio ſic vis*. This is preciſely the propoſition juſt now aſſerted as a general fact, a law of nature. This diſſertation is full of curious obſervations of facts in ſupport of his aſſertion. In his application to the motion of bodies he gives his noble diſcovery of the balance-ſpring of a watch, which is founded on this law. The ſpring, as it is more and more coiled up, or unwound, by the motion of the balance, acts on it with a force proportional to the diſtance of the balance from its quieſcent poſition. The balance therefore is acted on by an accelerating force, which varies in the ſame manner as the force of gravity

19 Law of nature diſcovered by Dr Hooke.

gravity acting on a pendulum ſwinging in a cycloid. Its vibrations therefore muſt be performed in equal time, whether they are wide or narrow. In the ſame diſſertation Hooke mentions all the facts which John Bernoulli afterwards adduced in ſupport of Leibnitz's whimſical doctrine of the force of bodies in motion, or the doctrine of the *vires vivæ;* a doctrine which Hooke might juſtly have claimed as his own, had he not ſeen its futility.

20
And confirmed by the experiments of others.

Experiments made ſince the time of Hooke ſhow that this law is ſtrictly true in the extent to which we have limited it, viz. in all the changes of form which will be completely undone by the elaſticity of the body. It is nearly true to a much greater extent. James Bernoulli, in his diſſertation on the elaſtic curve, relates ſome experiments of his own, which ſeem to deviate conſiderably from it; but on cloſe examination they do not. The fineſt experiments are thoſe of Coulomb, publiſhed in ſome late volumes of the memoirs of the Academy of Paris. He ſuſpended balls by wires, and obſerved their motions of oſcillation, which he found accurately correſponding with this law.

This we ſhall find to be a very important fact in the doctrine of the ſtrength of bodies, and we deſire the reader to make it familiar to his mind. If we apply to this our manner of expreſſing theſe forces by perpendicular ordinates Cc, Dd (fig. 1.), we muſt take other ſituations E, F, of the particle B, and draw Ee, Ff; and we muſt have $Dd : Ff = BD : BF$, or $Cc : Ee = BC : BE$. In ſuch a ſuppoſition $FdBce$ muſt be a ſtraight line. But we ſhall have abundant evidence by and bye that this cannot be ſtrictly true, and that the line Bce which limits the ordinates expreſſing the attractive forces becomes concave towards the line ABE, and that the part Bdf is convex towards it. All that can be ſafely concluded from the experiments hitherto made is, that *to a certain extent* the forces, both attractive and repulſive, are *ſenſibly* proportional to the dilatations and compreſſions. For,

21
When a body is much dilated, a ſmall addition of force will increaſe its dilatation.

5. It is univerſally obſerved, that when the dilatations have proceeded a certain length, a leſs addition of force is ſufficient to increaſe the dilatation in the ſame degree. This is always obſerved when the body has been ſo far ſtretched that it takes a ſet, and does not completely recover its form. The like may be generally obſerved in compreſſions. Moſt perſons will recollect, that in violently ſtretching an elaſtic cord, it becomes ſuddenly weaker, or more eaſily ſtretched. But theſe phenomena do not poſitively prove a diminution of the corpuſcular force acting on one particle: It more probably ariſes from the diſunion of ſome particles, whoſe action contributed to the whole or ſenſible effect. And in compreſſions we may ſuppoſe ſomething of the ſame kind; for when we compreſs a body in one direction, it commonly bulges out in another; and in caſes of very violent action ſome particles may be diſunited, whoſe tranſverſe action had formerly balanced *part* of the compreſſing force. For the reader will ſee on reflection, that ſince the compreſſion in one direction cauſes the body to bulge out in the tranſverſe direction; and ſince this bulging out is in oppoſition to the tranſverſe forces of attraction, it muſt employ ſome part of the compreſſing force. And the common appearances are in perfect uniformity with this conception of things. When we preſs a bit of dryiſh clay, it ſwells out and cracks tranſverſely. When a pillar of wood is overloaded, it ſwells out, and ſmall crevices appear in the direction of the fibres. After this it will not bear half of the load. This the carpenters call CRIPPLING; and a knowledge of the circumſtances which modify it is of great importance, and enables us to underſtand ſome very paradoxical appearances, as will be ſhown by and bye.

This partial diſuniting of particles formerly cohering is, we imagine, the chief reaſon why the totality of the forces which really oppoſe an external ſtrain does not increaſe in the proportion of the extenſions and compreſſions. But ſufficient evidence will alſo be given that the forces which would connect one particle with one other particle do not augment in the accurate proportion of the change of diſtance; that in extenſions they increaſe more ſlowly, and in compreſſions more rapidly.

22
Ductility another cauſe of deviation.

But there is another cauſe of this deviation perhaps equally effectual with the former. Moſt bodies manifeſt ſome degree of ductility. Now what is this? The fact is, that the parts have taken a new arrangement, in which they again cohere. Therefore, in the paſſage to this new arrangement, the ſenſible forces, which are the joint reſult of many corpuſcular forces, begin to reſpect this new arrangement inſtead of the former. This muſt change the ſimple law of corpuſcular force, characteriſtic of the particular ſpecies of matter under examination. It does not require much reflection to convince us that the poſſible arrangements which the particles of a body may acquire, without appearing to change their nature, muſt be more numerous according as the particles are of a more complex conſtitution; and it is reaſonable to ſuppoſe that the conſtitution even of the moſt ſimple kind of matter that we are acquainted with is exceedingly complex. Our microſcopes ſhow us animals ſo minute, that a heap of them muſt appear to the naked eye an uniform maſs with a grain finer than that of the fineſt marble or razor hone; and yet each of theſe has not only limbs, but bones, muſcular fibres, blood-veſſels, fibres, and a blood conſiſting, in all probability, of globules organiſed and complex like our own. The imagination is here loſt in wonder; and nothing is left us but to adore inconceivable art and wiſdom, and to exult in the thought that we are the only ſpectators of this beautiful ſcene who can derive pleaſure from the view. What is trodden under foot with indifference, even by the half-reaſoning elephant, may be made by us the ſource of the pureſt and moſt unmixed pleaſure. But let us proceed to obſerve,

23
The forces which connect the particles of tangible bodies change by a change of diſtance.

6. That the forces which connect the particles of tangible bodies change by a change of diſtance, not only in degree, but alſo in kind. The particle B (fig. 1.) is attracted by A when in the ſituation C or E. It is repelled by it when at D or F. It is not affected by it when in the ſituation B. The reader is requeſted carefully to remark, that this is not an inference founded on the authority of our mathematical figure. The figure is an expreſſion (to aſſiſt the imagination) of facts in nature. It requires no force to keep the particles of a body in their quieſcent ſituations: but if they are ſeparated by ſtretching the body, they endeavour (pardon the figurative expreſſion) to come together again. If they are brought nearer by compreſſion, they endeavour to recede. This endeavour is manifeſted by the neceſſity of employing force to maintain the extenſion or condenſation; and we repreſent this by the different poſition of

Strength of Materials.

of our lines. But this is not all: the particle B, which is repelled by A when in the situation F or D, is neutral when at B, and is attracted when at C or E, may be placed at such a distance AG from A greater than AB that it shall be again repelled, or at such a distance AH that it shall again be attracted; and these alterations may be repeated again and again. This is curious and important, and requires something more than a bare assertion for its proof.

24
Light alternately attracted and repelled.

In the article OPTICS we mentioned the most curious and valuable observations of Sir Isaac Newton, by which it appears that light is thus alternately attracted and repelled by bodies. The rings of colour which appear between the object glasses of long telescopes showed, that in the small interval of $\frac{1}{1000}$th of an inch, there are at least an hundred such changes observable, and that it is highly probable that these alternations extend to a much greater distance. At one of these distances the light actually converges towards the solid matter of the glass, which we express shortly, by saying that it is attracted by it, and that at the next distance it declines from the glass, or is repelled by it. The same thing is more simply inferred from the phenomena of light passing by the edges of knives and other opaque bodies. We refer the reader to the experiments themselves, the detail being too long for this place; and we request him to consider them minutely and attentively, and to form distinct notions of the inferences drawn from them. And we desire it to be remarked, that although Sir Isaac, in his discussion, always considers light as a set of corpuscles moving in free space, and obeying the actions of external forces like any other matter, the particular conclusion in which we are just now interested does not at all depend on this notion of the nature of light. Should we, with Des Cartes or Huygens, suppose light to be the undulation of an elastic medium, the conclusion will be the same. The undulations at certain distances are disturbed by forces directed towards the body, and at a greater distance, the disturbing forces tend *from* the body.

25
The same alternations of attraction and repulsion observable in the particles of other bodies, as glass.

But the same alternations of attraction and repulsion may be observed between the particles of common matter. If we take a piece of very flat and well-polished glass, such as is made for the horizon glasses of a good Hadley's quadrant, and if we wrap round it a fibre of silk as it comes from the cocoon, taking care that the fibre nowhere cross another, and then press this pretty hard on such another piece of glass, it will lift it up and keep it suspended. The particles therefore of the one do most certainly attract those of the other, and this at a distance equal to the thickness of the silk fibre. This is nearly the limit; and it sometimes requires a considerable pressure to produce the effect. The pressure is effectual only by compressing the silk fibre, and thus diminishing the distance between the glass plates. This adhesion cannot be attributed to the pressure of the atmosphere, because there is nothing to hinder the air from insinuating itself between the plates, since they are separated by the silk. Besides, the experiment succeeds equally well under the receiver of an air-pump. This most valuable experiment was first made by Huygens, who reported it to the Royal Society. It is narrated in the Philosophical Transactions, N° 86.

Here then is an attraction acting, like gravity, at a distance. But take away the silk fibre, and try to make the glasses touch each other, and we shall find a very great force necessary. By Newton's experiments it appears, that unless the prismatic colours begin to appear between the glasses, they are at least $\frac{1}{890}$th of an inch asunder or more. Now we know that a very considerable force is necessary for producing these colours, and that the more we press the glasses together the more rings of colours appear. It also appears from Newton's measures, that the difference of distance between the glasses where each of these colours appear is about the 89,000th part of an inch. We know farther, that when we have produced the last appearance of a greasy or pearly colour, and then augment the pressure, making it about a thousand pounds on the square inch, all colours vanish, and the two pieces of glass seem to make one transparent undistinguishable mass. They appear now to have no air between them, or to be in mathematical contact. But another fact shows this conclusion to be premature. The same circles of colours appear in the top of a soap bubble; and as it grows thinner at top, there appears an unreflecting spot in the middle. We have the greatest probability therefore that the perfect transparency in the middle of the two glasses does not arise from their being in contact, but because the thickness of air between them is too small in that place for the reflection of light. Nay, Newton expressly found no reflection where the thickness was $\frac{2}{5}$ths or more of the $\frac{1}{89000}$th part of an inch.

All this while the glasses are strongly repelling each other, for great pressure is necessary for continuing the appearance of those colours, and they vanish in succession as the pressure is diminished. This vanishing of the colours is a proof that the glasses are moving off from each other, or repelling each other. But we can put an end to this repulsion by very strong pressure, and at the same time sliding the glasses on each other. We do not pretend to account for this effect of the sliding motion; but the fact is, that by so doing, the glasses will cohere with very great force, so that we shall break them by any attempt to pull them asunder. It commonly happens (at least it did so with us), that in this sliding compression of two smooth flat plates of glass they scratch and mutually destroy each other's surface. It is also worth remarking, that different kinds of glass exhibit different properties in this respect. Flint glass will attract even though a silk fibre lies double between them, and they much more readily cohere by this sliding pressure.

Here then are two distances at which the plates of glass attract each other; namely, when the silk fibre is interposed, and when they are forced together with this sliding motion. And in any intermediate situation they repel each other. We see the same thing in other solid bodies. Two pieces of lead made perfectly clean, may be made to cohere by grinding them together in the same manner. It is in this way that pretty ornaments of silver are united to iron. The piece is scraped clean, and a small bit of silver like a fish scale is laid on. The die which is to strike it into a flower or other ornament is then set on it, and we give it a smart blow, which forces the metals into contact as firm as if they were soldered together. It sometimes happens that the die adheres to the coin so that they cannot be separated: and it is found that this frequently happens, when the engraving is such, that the raised figure is not complete-

26
Lead and iron.

ly

ly ſurrounded with a ſmooth flat ground. The probable cauſe of this is curious. When the coin has a flat ſurface all around, this is produced by the moſt prominent part of the die. This applies to the metal, and completely confines the air which filled the hollow of the die. As the preſſure goes on, the metal is ſqueezed up into the hollow of the die; but there is ſtill air compreſſed between them, which cannot eſcape by any paſſage. It is therefore prodigiouſly condenſed, and exerts an elaſticity proportioned to the condenſation. This ſerves to ſeparate the die from the metal when the ſtroke is over. The hollow part of the die has not touched the metal all the while, and we may ſay that the impreſſion was made by air. If this air eſcape by any engraving reaching through the border, they cohere inſeparably.

27 Probable cauſe why the die adheres to the coin.

We have admitted that the glaſs plates are in contact when they cohere thus firmly. But we are not certain of this: for if we take theſe cohering glaſſes, and touch them with water, it quickly inſinuates itſelf between them. Yet they ſtill cohere, but can now be pretty eaſily ſeparated.

28 Repulſion the cauſe of ſome bodies ſwimming in a fluid ſpecifically lighter than themſelves.

It is owing to this repulſion, exerted through its proper ſphere, that certain powders ſwim on the ſurface of water, and are wetted with great difficulty. Certain inſects can run about on the ſurface of water. They have bruſhy feet, which occupy a conſiderable ſurface; and if their ſteps are viewed with a magnifying glaſs, the ſurface of the water is ſeen depreſſed all around, reſembling the footſteps of a man walking on feather-beds. This is owing to a repulſion between the bruſh and the water. A common fly cannot walk in this manner on water. Its feet are wetted, becauſe they attract the water inſtead of repelling it. A ſteel needle, wiped very clean, will lie on the ſurface of water, making an impreſſion as a great bar would make on a feather bed; and its weight is leſs than that of the diſplaced water. A dew drop lies on the leaves of plants without touching them mathematically, as is plain from the extreme brilliancy of the reflection at the poſterior ſurface; nay, it may be ſometimes obſerved that the drops of rain lie on the ſurface of water, and roll about on it like balls on a table. Yet all theſe ſubſtances can be wetted; that is, water can be applied to them at ſuch diſtances that they attract it.

What we ſaid a little ago of water inſinuating itſelf between the glaſs plates without altogether deſtroying their coheſion, ſhows that this coheſion is not the ſame that obtains between the particles of one of the plates; that is, the two plates are not in the ſtate of one continued maſs. It is highly probable, therefore, that between theſe two ſtates there is an intermediate ſtate of repulſion, nay, perhaps many ſuch, alternated with attractive ſtates.

A piece of ice is elaſtic, for it rebounds and rings. Its particles, therefore, when compreſſed, reſile; and when ſtretched, contract again. The particles are therefore in the ſtate repreſented by B in figure 1. acted on by repulſive forces, if brought nearer; and by attractive forces, if drawn further aſunder. Ice expands, like all other bodies, by heat. It abſorbs a vaſt quantity of fire; which, by combining its attractions and repulſions with thoſe of the particles of ice, changes completely the law of action, without making any ſenſible change in the diſtance of the particles, and the ice becomes water. In this new ſtate the particles are again in limits between attractive and repulſive forces; for water has been ſhown, by the experiments of Canton and Zimmerman, to be elaſtic or compreſſible. It again expands by heat. It again abſorbs a prodigious quantity of heat, and becomes elaſtic vapour; its particles repelling each other at all diſtances yet obſerved. The diſtance between the particles of one plate of glaſs and thoſe of another which lies on it, and is carried by it, is a diſtance of repulſion; for the force which ſupports the upper piece is acting in oppoſition to its weight. This diſtance is leſs than that at which it would *ſuſpend* it below it with a ſilk fibre interpoſed; for no priſmatic colours appear between them when the ſilk fibre is interpoſed. But the diſtance at which glaſs attracts water is much leſs than this, for no colours appear when glaſs is wetted with water. This diſtance is leſs, and not greater, than the other; for when the glaſſes have water interpoſed between them inſtead of air, it is found, that when any particular colour appears, the thickneſs of the plate of water is to that of the plate of air which would produce the ſame colour nearly as 3 to 4. Now, if a piece of glaſs be wetted, and exhibit no colour, and another piece of glaſs be ſimply laid on it, no colour will appear; but if they are ſtrongly preſſed, the colours appear in the ſame manner as if the glaſſes had air between. Alſo, when glaſs is ſimply wetted, and the film of water is allowed to evaporate, when it is thus reduced to a proper thinneſs, the colours ſhow themſelves in great beauty.

29 Particles of matter connected by forces acting at a diſtance.

Theſe are a few of many thouſand facts, by which it is unqueſtionably proved that the particles of tangible matter are connected by forces acting at a diſtance, varying with the diſtance, and alternately attractive and repulſive. If we repreſent theſe forces as we have already done in fig. 1. by the ordinates C *c*, D *d*, E *e*, F *f*, &c. of a curve, it is evident that this curve muſt croſs the axis at all thoſe diſtances where the forces change from attractive to repulſive, and the curve muſt have branches alternately above and below the axis.

All theſe alternations of attraction and repulſion take place at ſmall and inſenſible diſtances. At all ſenſible diſtances the particles are influenced by the attraction of gravitation; and therefore this part of the curve muſt be a hyperbola whoſe equation is $y=\frac{a^3}{x^2}$. What is the form of the curve correſponding to the ſmalleſt diſtance of the particles? that is, what is the mutual action between the particles juſt before their coming into abſolute contact? Analogy ſhould lead us to ſuppoſe it to be repulſion: for ſolidity is the laſt and ſimpleſt form of bodies with which we are acquainted.—Fluids are more compounded, containing fire as an eſſential ingredient. We ſhould conclude that this ultimate repulſion is inſuperable, for the hardeſt bodies are the moſt elaſtic. We are fully entitled to ſay, that this repelling force exceeds all that we have ever yet applied to overcome it; nay, there are good reaſons for ſaying that this ultimate repulſion, by which the particles are kept from mathematical contact, is really inſuperable in its own nature, and that it is impoſſible to produce mathematical contact.

30 Mathematical contact impoſſible.

We ſhall juſt mention one of theſe, which we conſider as unanſwerable. Suppoſe two atoms, or ultimate particles of matter A and B. Let A be at reſt, and B move

move up to it with the velocity 2; and let us fuppofe that it comes into mathematical contact, and impels it (according to the common acceptation of the word). Both move with the velocity 1. This is granted by all to be the final refult of the collifion. Now the inftant of time in which this communication happens is no part either of the duration of the folitary motion of A, nor of the joint motion of A and B: It is the feparation or boundary between them. It is at once the end of the firft, and the beginning of the fecond, belonging equally to both. A was moving with the velocity 2. The diftinguifhing circumftance therefore of its mechanical ftate is, that it has a determination (however incomprehenfible) by which it would move for ever with the velocity 2, if nothing changed it. This it has during the whole of its folitary motion, and therefore in the laft inftant of this motion. In like manner, during the whole of the joint motion, and therefore in the firft inftant of this motion, the atom A has a determination by which it would move for ever with the velocity 1. In one and the fame inftant, therefore, the atom A has two incompatible determinations. Whatever notion we can form of this ftate, which we call velocity, as a diftinction of condition, the fame impoffibility of conception or the fame abfurdity occurs. Nor can it be avoided in any other way than by faying, that this change of A's motion is brought about by infenfible gradations; that is, that A and B influence each other precifely as they would do if a flender fpring were interpofed. The reader is defired to look at what we have faid in the article PHYSICS, § 82.

The two magnets there fpoken of are good reprefentatives of two atoms endowed with mutual powers of repulfion; and the communication of motion is accomplifhed in both cafes in precifely the fame manner.

If, therefore, we fhall ever be fo fortunate as to difcover the law of variation of that force which connects one ATOM of matter with another atom, and which is therefore characteriftic of matter, and the ultimate fource of all its fenfible qualities, the curve whofe ordinates reprefent the kind and the intenfity of this atomical force

Fig. 2. will be fomething like that fketched in fig. 2. The firft branch $a\,n$ B will have AK (perpendicular to the axis AH) for its affymptote, and the laft branch $l\,m\,o$ will be to all fenfe a hyperbola, having AO for its affymptote; and the ordinates l L, m M, &c. will be proportional to $\frac{1}{\mathrm{AL}^2}$, $\frac{1}{\mathrm{AM}^2}$, &c. expreffing the univerfal gravitation of matter. It will have many branches B b C, D d E, F f G, &c. expreffing attractions, and alternate repulfive branches C c D, E e F, G g H, &c. All thefe will be contained within a diftance AH, which does not exceed a very minute fraction of an inch.

31
The fimpleft extended particle confifts of four atoms.

The fimpleft particle which can be a conftituent of a body having length, breadth, and thicknefs, muft confift of four fuch atoms, all of which combine their influence on each atom of another fuch particle. It is evident that the curve which expreffes the forces that connect two fuch particles muft be totally different from this original curve, this hylarchic principle. Suppofing the laft known, our mathematical knowledge is quite able to difcover the firft: but when we proceed to compofe a body of particles, each of which confifts of four fuch particles, we may venture to fay, that the compound force which connects them is almoft beyond our fearch, and that the difcovery of the primary force from an *accurate* knowledge of the corpufcular forces of *this* particular matter is abfolutely out of our power.

All that we can learn is, the poffibility, nay the certainty, of an innumerable variety of external fenfible forms and qualities, by which different kinds of matter will be diftinguifhed, arifing from the number, the order of compofition, and the arrangement of the fubordinate particles of which a particle of this or that kind of matter is compofed. All thefe varieties will take place at thofe fmall and infenfible diftances which are between A and H, and may produce all that variety which we obferve in the tangible or mechanical forms of bodies, fuch as elafticity, ductility, hardnefs, foftnefs, fluidity, vapour, and all thofe unfeen motions or actions which we obferve in fufion and congelation, evaporation and condenfation, folution and precipitation, cryftallization, vegetable and animal affimilation and fecretion, &c. &c. &c. while all bodies muft be, in a certain degree, elaftic, all muft gravitate, and all muft be incompenetrable.

This general and fatisfactory refemblance between the appearance of tangible matter and the legitimate confequence of this general hypothetical property of an atom of matter, affords a confiderable probability that fuch is the origin of all the phenomena. We earneftly recommend to our readers a *careful* perufal of Bofcovich's celebrated treatife. A careful perufal is neceffary for feeing its value; and nothing will be got by a hafty look at it. The reader will be particularly pleafed with the facility and evidence with which the ingenious author has deduced all the ordinary principles of mechanics, and with the explanation which he has given of fluidity, and his deduction from thence of the laws of hydroftatics. No part of the treatife is more valuable than the doctrine of the propagation of preffure through folid bodies. This, however, is but juft touched on in the courfe of the inveftigation of the principles of mechanics. We fhall borrow as much as will fuffice for our prefent inquiry into the ftrength of materials; and we truft that our readers are not difpleafed with this general fketch of the doctrine (if it may be fo called) of the cohefion of bodies. It is curious and important in itfelf, and is the foundation of all the knowledge we can acquire of the prefent article. We are forry to fay that it is as yet a new fubject of ftudy; but it is a very promifing one, and we by no means defpair of feeing the whole of chemiftry brought by its means within the pale of mechanical fcience. The great and diftinguifhing agent in chemiftry is heat, or fire the caufe of heat; and one of its moft fingular effects is the converfion of bodies into elaftic vapour. We have the cleareft evidence that this is brought about by mechanical forces: for it can be oppofed or prevented by external preffure, a very familiar mechanical force. We may perhaps find another mechanical force which will prevent fufion.

32
The doctrine of cohefion yet a new fubject.

HAVING now made our readers familiar with the mode of action in which cohefion operates in giving ftrength to folid bodies, we proceed to confider the ftrains to which this ftrength is oppofed.

33
Strains to which ftrength is oppofed.

A piece of folid matter is expofed to four kinds of ftrains, pretty different in the manner of their operation.

1. It may be torn afunder, as in the cafe of ropes, ftretchers, king-pofts, tye-beams, &c.

2.

2. It may be cruſhed, as in the caſe of pillars, poſts, and truſs beams.

3. It may be broken acroſs, as happens to a joiſt or lever of any kind.

4. It may be wrenched or twiſted, as in the caſe of the axle of a wheel, the nail of a preſs, &c.

I. It may be pulled asunder.

34 Matter may be pulled aſunder.

This is the ſimpleſt of all ſtrains, and the others are indeed modifications of it. To this the force of coheſion is *directly* oppoſed, with very little modification of its action by any particular circumſtances.

When a long cylindrical or priſmatic body, ſuch as a rod of wood or metal, or a rope, is drawn by one end, it muſt be reſiſted at the other, in order to bring its coheſion into action. When it is faſtened at one end, we cannot conceive it any other way than as equally ſtretched in all its parts; for all our obſervations and experiments on natural bodies concur in ſhowing us that the forces which connect their particles, in any way whatever, are equal and oppoſite. This is called the *third law of motion*; and we admit its univerſality, while we affirm that it is purely experimental (ſee Physics). Yet we have met with diſſertations by perſons of eminent knowledge, where propoſitions are maintained inconſiſtent with this. During the diſpute about the communication of motion, ſome of the ableſt writers have ſaid, that a ſpring compreſſed or ſtretched at the two ends was gradually leſs and leſs compreſſed or ſtretched from the extremities towards the middle: but the ſame writers acknowledged the univerſal equality of action and reaction, which is quite incompatible with this ſtate of the ſpring. No ſuch inequality of compreſſion or dilatation has ever been obſerved; and a little reflection will ſhow it to be impoſſible, in conſiſtency with the equality of action and reaction.

Since all parts are thus equally ſtretched, it follows, that the ſtrain in any tranſverſe ſection is the ſame, as alſo in every point of that ſection. If therefore the body be ſuppoſed of a homogeneous texture, the coheſion of the parts is equable; and ſince every part is equally ſtretched, the particles are drawn to equal diſtances from their quieſcent poſitions, and the forces which are thus excited and now exerted in oppoſition to the ſtraining force, are equal. This external force may be increaſed by degrees, which will gradually ſeparate the parts of the body more and more from each other, and the connecting forces increaſe with this increaſe of diſtance, till at laſt the coheſion of ſome particles is overcome. This muſt be immediately followed by a rupture, becauſe the remaining forces are now weaker than before.

It is the united force of coheſion, immediately before the diſunion of the firſt particles, that we call the strength of the ſection. It may alſo be properly called its absolute strength, being exerted in the ſimpleſt form, and not modified by any relation to other circumſtances.

35 A circumſtance to be attended to in every conſtruction requiring ſtrength.

If the external force has not produced any permanent change on the body, and it therefore recovers its former dimenſions when the force is withdrawn, it is plain that this ſtrain may be repeated as often as we pleaſe, and the body which withſtands it once will always withſtand it. It is evident that this ſhould be attended to in all conſtructions, and that in all our inveſtigations on this ſubject this ſhould be kept ſtrictly in view. When we treat a piece of ſoft clay in this manner, and with this precaution, the force employed muſt be very ſmall. If we exceed this, we produce a permanent change. The rod of clay is not indeed torn aſunder; but it has become ſomewhat more ſlender: the number of particles in a croſs ſection is now ſmaller; and therefore, although it will again, in this new form, ſuffer, or allow an endleſs repetition of a *certain* ſtrain without any farther permanent change, this ſtrain is ſmaller than the former.

Something of the ſame kind happens in all bodies which receive a sett by the ſtrain to which they are expoſed. All ductile bodies are of this kind. But there are many bodies which are not ductile. Such bodies break completely whenever they are ſtretched beyond the limit of their perfect elaſticity. Bodies of a fibrous ſtructure exhibit very great varieties in their coheſion. 36

36 Great varieties in coheſion, but

In ſome the fibres have no lateral coheſion, as in the caſe of a rope. The only way in which all the fibres can be made to unite their ſtrength is, to twiſt them together. This cauſes them to bind each other ſo faſt, that any one of them will break before it can be drawn out of the bundle. In other fibrous bodies, ſuch as timber, the fibres are held together by ſome cement or gluten. This is ſeldom as ſtrong as the fibre. Accordingly timber is much eaſier pulled aſunder in a direction tranſverſe to the fibres. There is, however, every poſſible variety in this particular.

In ſtretching and breaking fibrous bodies, the viſible extenſion is frequently very conſiderable. This is not ſolely the increaſing of the diſtance of the particles of the cohering fibre: the greateſt part chiefly ariſes from drawing the crooked fibre ſtraight. In this, too, there is great diverſity; and it is accompanied with important differences in their power of withſtanding a ſtrain. In ſome woods, ſuch as fir, the fibres on which the ſtrength moſt depends are very ſtraight. Such woods are commonly very elaſtic, do not take a ſett, and break abruptly when overſtrained: others, ſuch as oak and birch, have their reſiſting fibres very undulating and crooked, and ſtretch very ſenſibly by a ſtrain. They are very liable to take a ſet, and they do not break ſo ſuddenly, but give warning by *complaining*, as the carpenters call it; that is, by giving viſible ſigns of a derangement of texture. Hard bodies of an uniform glaſſy ſtructure, or granulated like ſtones, are elaſtic through the whole extent of their coheſion, and take no ſett, but break at once when overloaded.

Notwithſtanding the immenſe variety which nature exhibits in the ſtructure and coheſion of bodies, there are certain general facts of which we may now avail ourſelves with advantage. In particular, 37

37 The abſolute coheſion or ſtrength proportional to the area of the ſection perpendicular to the extending force.

The abſolute coheſion is proportional to the area of the ſection. This muſt be the caſe where the texture is perfectly uniform, as we have reaſon to think it is in glaſs and the ductile metals. The coheſion of each particle being alike, the whole coheſion muſt be proportional to their number, that is, to the area of the ſection. The ſame muſt be admitted with reſpect to bodies of a granulated texture, where the granulation is regular and uniform. The ſame muſt be admitted of fibrous bodies, if we ſuppoſe their fibres equally ſtrong, equally denſe, denfe, and fimilarly difpofed through the whole fection; and this we muft either fuppofe, or muft ftate the diverfity, and meafure the cohefion accordingly.

We may therefore affert, as a general propofition on this fubject, that the abfolute ftrength in any part of a body by which it refifts being pulled afunder, or the force which muft be employed to tear it afunder *in that part*, is proportional to the area of the fection perpendicular to the extending force.

Therefore all cylindrical or prifmatical rods are equally ftrong in every part, and will break alike in any part; and bodies which have unequal fections will always break in the flendereft part. The length of the cylinder or prifm has no effect on the ftrength; and the vulgar notion, that it is eafier to break a very long rope than a fhort one, is a very great miftake. Alfo the abfolute ftrengths of bodies which have fimilar fections are proportional to the fquares of their diameters or homologous fides of the fection.

The weight of the body itfelf may be employed to ftrain it and to break it. It is evident, that a rope may be fo long as to break by its own weight. When the rope is hanging perpendicularly, although it is equally ftrong in every part, it will break towards the upper

38 Relative ftrength.

end, becaufe the ftrain on any part is the weight of all that is below it. Its RELATIVE STRENGTH in any part, or power of withftanding the ftrain which is actually laid on it, is inverfely as the quantity below that part.

When the rope is ftretched horizontally, as in towing a fhip, the ftrain arifing from its weight often bears a very fenfible proportion to its whole ftrength.

Fig. 3. Let AEB (fig. 3.) be any portion of fuch a rope, and AC, BC be tangents to the curve into which its gravity bends it. Complete the parallelogram ACBD. It is well known that the curve is a catenaria, and that DC is perpendicular to the horizon; and that DC is to AC as the weight of the rope AEB to the ftrain at A.

In order that a fufpended heavy body may be equally able in every part to carry its own weight, the fection in that part muft be proportional to the folid contents of all that is below it. Suppofe it a conoidal fpindle, formed by the revolution of the curve A a e

Fig. 4. (fig. 4.) round the axis CE. We muft have $AC^2 : ac^2 = AEB$ fol. : a E b fol. This condition requires the logarithmic curve for A a c, of which C c is the axis.

Thefe are the chief general rules which can be fafely deduced from our cleareft notions of the cohefion of bodies. In order to make any practical ufe of them, it is proper to have fome meafures of the cohefion of fuch bodies as are commonly employed in our mechanics, and other ftructures where they are expofed to this kind of

39 The cohefion of metals depends on various circumftances

ftrain. Thefe muft be deduced folely from experiment. Therefore they muft be confidered as no more than general values, or as the averages of many particular trials. The irregularities are very great, becaufe none of the fubftances are conftant in their texture and firmnefs. Metals differ by a thoufand circumftances unknown to us, according to their purity, to the heat with which they were melted, to the moulds in which they were caft, and the treatment they have afterwards received, by forging, wire-drawing, tempering, &c.

It is a very curious and inexplicable fact, that by forging a metal, or by frequently drawing it through a fmooth hole in a fteel plate, its cohefion is greatly increafed. This operation undoubtedly deranges the natural fituation of the particles. They are fqueezed clofer together in one direction; but it is not in the direction in which they refift the fracture. In this direction they are rather feparated to a greater diftance. The general denfity, however, is augmented in all of them except lead, which grows rather rarer by wire-drawing; but its cohefion may be more than tripled by this operation. Gold, filver, and brafs, have their cohefion nearly tripled; copper and iron have it more than doubled. In this operation they alfo grow much harder. It is proper to heat them to rednefs after drawing a little. This is called *nealing* or *annealing*. It foftens the metal again, and renders it fufceptible of another drawing without the rifk of cracking in the operation.

We do not pretend to give any explanation of this remarkable and very important fact, which has fomething refembling it in woods and other fibrous bodies, as will be mentioned afterwards.

The varieties in the cohefion of ftones and other minerals, and of vegetable and animal fubftances, are hardly fufceptible of any defcription or claffification.

40 Cohefion and ftrength of different metals.

We fhall take for the meafure of cohefion the number of pounds avoirdupois which are juft fufficient to tear afunder a rod or bundle of one inch fquare. From this it will be eafy to compute the ftrength correfponding to any other dimenfion.

1*ft*, METALS.

		lbs,
Gold, caft		20,000
		24 000
Silver, caft		40,000
		43.000
Copper, caft	Japan	19,500
	Barbary	22,000
	Hungary	31.000
	Anglefea	34 000
	Sweden	37 000
Iron, caft		42,000
		59,000
Iron, bar	Ordinary	68,000
	Stirian	75,000
	Beft Swedifh and Ruffian	84,000
	Horfe-nails	71,000 (A)
Steel, bar	Soft	120,000
	Razor temper	150.000
Tin, caft	Malacca	3,100
	Banca	3,600
	Block	3 800
	Englifh block	5.200
	——— grain	6,500
Lead, caft		860
Regulus of antimony		1,000
Zinc		2,600
Bifmuth		2,900

It

(A) This was an experiment by Mufchenbroek, to examine the vulgar notion that iron forged from old horfe nails was ftronger than all others, and fhows its falfity.

41 Tenacity of metals increaſed by mixtures.

It is very remarkable that almoſt all the mixtures of metals are more tenacious than the metals themſelves. The change of tenacity depends much on the proportion of the ingredients, and the proportion which produces the moſt tenacious mixture is different in the different metals. We have ſelected the following from the experiments of Muſchenbroek. The proportion of ingredients here ſelected is that which produces the greateſt ſtrength.

Two parts of gold with one of ſilver -	28,000
Five parts of gold with one of copper -	50,000
Five parts of ſilver with one of copper -	48,500
Four parts of ſilver with one of tin -	41,000
Six parts of copper with one of tin -	41,000
Five parts of Japan copper with one of Banca tin - - - - . - -	57,000
Six parts of Chili copper with one of Malacca tin - - - -	60,000
Six parts of Swediſh copper with one of Malacca tin - - -	64,000
Braſs conſiſts of copper and zinc in an unknown proportion; its ſtrength is	51,000
Three parts of block tin with one part of lead - - - -	10,200
Eight parts of block tin with one part of zinc - - - -	10,000
Four parts of Malacca tin with one part of regulus of antimony . -	12,000
Eight parts of lead with one of zinc -	4,500
Four parts of tin with one of lead and one of zinc - - -	13,000

Theſe numbers are of conſiderable uſe in the arts. The mixtures of copper and tin are particularly intereſting in the fabric of great guns. We ſee that, by mixing copper whoſe greateſt ſtrength does not exceed 37,000, with tin which does not exceed 6000, we produce a metal whoſe tenacity is almoſt double, at the ſame time that it is harder and more eaſily wrought. It is, however, more fuſible, which is a great inconvenience. We alſo ſee that a very ſmall addition of zinc almoſt doubles the tenacity of tin, and increaſes the tenacity of lead five times; and a ſmall addition of lead doubles the tenacity of tin. Theſe are economical mixtures. This is a very valuable information to the plumbers for augmenting the ſtrength of water-pipes.

By having recourſe to theſe tables, the engineer can proportion the thickneſs of his pipes (of whatever metal) to the preſſures to which they are expoſed.

2d, Woods.

We may premiſe to this part of the table the following general obſervations.

42 Tenacity or ſtrength of wood.

1. The wood immediately ſurrounding the pith or heart of the tree is the weakeſt, and its inferiority is ſo much more remarkable as the tree is older. In this aſſertion, however, we ſpeak with ſome heſitation. Muſchenbroek's *detail* of experiments is decidedly in the affirmative. M Buffon, on the other hand, ſays, that his experience has taught him that the heart of a ſound tree is the ſtrongeſt; but he gives no inſtances. We are certain, from many obſervations of our own, on very *large* oaks and firs, that the heart is much weaker than the exterior parts.

2. The wood next the bark, commonly called the *white* or *blea*, is alſo weaker than the reſt; and the wood gradually increaſes in ſtrength as we recede from the centre to the blea.

3. The wood is ſtronger in the middle of the trunk than at the ſpringing of the branches or at the root; and the wood of the branches is weaker than that of the trunk.

4. The wood of the north ſide of all trees which grow in our European climates is the weakeſt, and that of the ſouth-eaſt ſide is the ſtrongeſt; and the difference is moſt remarkable in hedge-row trees, and ſuch as grow ſingly. The heart of a tree is never in its centre, but always nearer to the north ſide, and the annual coats of wood are thinner on that ſide. In conformity with this, it is a general opinion of carpenters that timber is ſtronger whoſe annual plates are thicker. The trachea or air-veſſels are weaker than the ſimple ligneous fibres. Theſe air-veſſels are the ſame in diameter and number of rows in trees of the ſame ſpecies, and they make the viſible ſeparation between the annual plates. Therefore when theſe are thicker, they contain a greater proportion of the ſimple ligneous fibres.

5. All woods are more tenacious while green, and loſe very conſiderably by drying after the trees are felled.

The only author who has put it in our power to judge of the propriety of his experiments is Muſchenbroek. He has deſcribed his method of trial minutely; and it ſeems unexceptionable. The woods were all formed into ſlips fit for his apparatus, and part of the ſlip was cut away to a parallelopiped of $\frac{1}{5}$th of an inch ſquare, and therefore $\frac{1}{25}$th of a ſquare inch in ſection. The abſolute ſtrengths of a ſquare inch were as follow:

43 Abſolute ſtrength of different kinds of wood.

	lib.		lib.
Locuſt tree	20,100	Pomegranate	9,750
Jujeb -	18,500	Lemon	9,250
Beech, oak	17,300	Tamarind	8,750
Orange -	15,500	Fir -	8,330
Alder -	13,900	Walnut -	8,130
Elm -	13,200	Pitch pine	7,650
Mulberry -	12,500	Quince -	6,750
Willow -	12,500	Cypreſs -	6,000
Aſh -	12,000	Poplar -	5,500
Plum -	11,800	Cedar -	4,880
Elder -	10,000		

Mr Muſchenbroek has given a very minute detail of the experiments on the aſh and the walnut, ſtating the weights which were required to tear aſunder ſlips taken from the four ſides of the tree, and on each ſide, in a regular progreſſion from the centre to the circumference. The numbers of this table correſponding to theſe two timbers may therefore be conſidered as the average of more than 50 trials made of each; and he ſays that all the others were made with the ſame care. We cannot therefore ſee any reaſon for not confiding in the reſults; yet they are conſiderably higher than thoſe given by ſome other writers. Mr Pitot ſays, on the authority of his own experiments, and of theſe of Mr Parent, that 60 pounds will juſt tear aſunder a ſquare line of ſound oak, and that it will bear 50 with ſafety. This gives 8640 for the utmoſt ſtrength of a ſquare inch, which is much inferior to Muſchenbroek's valuation.

We may add to theſe,

Ivory

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44
and of other substances.

Ivory	16,270
Bone	5,250
Horn	8,750
Whalebone	7,500
Tooth of sea-calf	4,075

45
No substance to be strained in architecture above one half its strength.

The reader will surely observe, that these numbers express something more than the utmost cohesion; for the weights are such as will very quickly, that is, in a minute or two, tear the rods asunder. It may be said in general, that two thirds of these weights will sensibly impair the strength after a considerable while, and that one-half is the utmost that can remain suspended at them without risk for ever; and it is this last allotment that the engineer should reckon upon in his constructions. There is, however, considerable difference in this respect. Woods of a very straight fibre, such as fir, will be less impaired by any load which is not sufficient to break them immediately.

According to Mr Emerson, the load which may be safely suspended to an inch square is as follows:

Iron	76,400
Brass	35,600
Hempen rope	19,600
Ivory	15,700
Oak, box, yew, plum-tree	7,850
Elm, ash, beech	6,070
Walnut, plum	5,360
Red fir, holly, elder, plane, crab	5,000
Cherry, hazel	4,760
Alder, asp, birch, willow	4,290
Lead	430
Freestone	914

He gives us a practical rule, that a cylinder whose diameter is d inches, loaded to one-fourth of its absolute strength, will carry as follows:

Iron	135	Cwt.
Good rope	22	
Oak	14	
Fir	9	

The rank which the different woods hold in this list of Mr Emerson's is very different from what we find in Muschenbroek's. But precise measures must not be expected in this matter. It is wonderful that in a matter of such unquestionable importance the public has not enabled some persons of judgement to make proper trials. They are beyond the abilities of private persons.

II. Bodies may be crushed.

46
It is of importance to know what will crush bodies.

It is of equal, perhaps greater, importance to know the strain which may be laid on solid bodies without danger of crushing them. Pillars and posts of all kinds are exposed to this strain in its simplest form; and there are cases where the strain is enormous, viz. where it arises from the oblique position of the parts; as in the struts, braces, and trusses, which occur very frequently in our great works.

It is therefore most desirable to have some general knowledge of the principle which determines the strength of bodies in opposition to this kind of strain. But unfortunately we are much more at a loss in this than in the last case. The mechanism of nature is much more complicated in the present case. It must be in some circuitous way that compression can have any tendency to tear asunder the parts of a solid body, and it is very difficult to trace the steps.

If we suppose the particles insuperably hard and in contact, and disposed in lines which are in the direction of the external pressures, it does not appear how any pressure can disunite the particles; but this is a gratuitous supposition. There are infinite odds against this precise arrangement of the lines of particles; and the compressibility of all kinds of matter in some degree shows that the particles are in a situation equivalent to distance. This being the case, and the particles, with their intervals, or what is equivalent to intervals, being in situations that are oblique with respect to the pressures, it must follow, that by squeezing them together in one direction, they are made to bulge out or separate in other directions. This may proceed so far that some may be thus pushed laterally beyond their limits of cohesion. The moment that this happens the resistance to compression is diminished, and the body will now be crushed together. We may form some notion of this by supposing a number of spherules, like small shot, sticking together by means of a cement. Compressing this in some particular direction causes the spherules to act among each other like so many wedges, each tending to penetrate through between the three which lie below it: and this is the simplest, and perhaps the only distinct, notion we can have of the matter. We have reason to think that the constitution of very homogeneous bodies, such as glass, is not very different from this. The particles are certainly arranged symmetrically in the angles of some regular solids. It is only such an arrangement that is consistent with transparency, and with the free passage of light in *every* direction.

47
Their strength or power of resistance to such a force

If this be the constitution of bodies, it appears probable that the strength, or the resistance which they are capable of making to an attempt to crush them to pieces, is proportional to the area of the section whose plane is perpendicular to the external force; for each particle being similarly and equally acted on and resisted, the whole resistance must be as their number; that is, as the extent of the section.

Accordingly this principle is assumed by the few writers who have considered this subject; but we confess that it appears to us very doubtful. Suppose a number of brittle or friable balls lying on a table uniformly arranged, but not cohering nor in contact, and that a board is laid over them and loaded with a weight; we have no hesitation in saying, that the weight necessary to crush the whole collection is proportional to their number or to the area of the section. But when they are in contact (and still more if they cohere), we imagine that the case is materially altered. Any individual ball is crushed only in consequence of its being bulged outwards in the direction perpendicular to the pressure employed. If this could be prevented by a hoop put round the ball like an equator, we cannot see how any force can crush it. Any thing therefore which makes this bulging outwards more difficult, makes a greater force necessary. Now this effect will be produced by the mere contact of the balls before the pressure is applied; for the central ball cannot swell outward laterally without pushing away the balls on all sides of it. This is prevented by the friction on the table and upper board

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of board, which is at leaſt equal to one third of the preſſure. Thus any interior ball becomes ſtronger by the mere vicinity of the others; and if we farther ſuppoſe them to cohere laterally, we think that its ſtrength will be ſtill more increaſed.

The analogy between theſe balls and the cohering particles of a friable body is very perfect. We ſhould therefore expect that the ſtrength by which it reſiſts being cruſhed will increaſe in a greater ratio than that of the ſection, or the ſquare of the diameter of ſimilar ſections; and that a ſquare inch of any matter will bear a greater weight in proportion as it makes a part of a greater ſection. Accordingly this appears in many experiments, as will be noticed afterwards. Muſchenbroek, Euler, and ſome others, have ſuppoſed the ſtrength of columns to be as the biquadrates of their diameters. But Euler deduced this from formulæ which occurred to him in the courſe of his algebraic analyſis; and he boldly adopts it as a principle, without looking for its foundation in the phyſical aſſumptions which he had made in the beginning of his inveſtigation. But ſome of his original aſſumptions were as paradoxical, or at leaſt as gratuitous, as theſe reſults: and thoſe, in particular, from which this proportion of the ſtrength of columns was deduced, were almoſt foreign to the caſe; and therefore the inference was of no value. Yet it was received as a principle by Muſchenbroek and by the academicians of St Peterſburgh. We make theſe very few obſervations, becauſe the ſubject is of great practical importance; and it is a great obſtacle to improvements when deference to a great name, joined to incapacity or indolence, cauſes authors to adopt his careleſs reveries as principles from which they are afterwards to draw important conſequences. It muſt be acknowledged that we have not as yet eſtabliſhed the relation between the dimenſions and the ſtrength of a pillar on ſolid mechanical principles. Experience plainly contradicts the general opinion, that the ſtrength is proportional to the area of the ſection; but it is ſtill more inconſiſtent with the opinion, that it is in the quadruplicate ratio of the diameters of ſimilar ſections. It would ſeem that the ratio depends much on the internal ſtructure of the body; and experiment ſeems the only method for aſcertaining its general laws.

48 to be aſcertained only by experiment.

If we ſuppoſe the body to be of a fibrous texture, having the fibres ſituated in the direction of the preſſure, and ſlightly adhering to each other by ſome kind of cement, ſuch a body will fail only by the bending of the fibres, by which they will break the cement and be detached from each other. Something like this may be ſuppoſed in wooden pillars. In ſuch caſes, too it would appear that the reſiſtance muſt be as the number of equally reſiſting fibres, and as their mutual ſupport, jointly; and, therefore, as ſome function of the area of the ſection. The ſame thing muſt happen if the fibres are naturally crooked or undulated, as is obſerved in many woods, &c. provided we ſuppoſe ſome ſimilarity in their form. Similarity of ſome kind muſt always be ſuppoſed, otherwiſe we need never aim at any general inferences.

In all caſes therefore we can hardly refuſe admitting that the ſtrength in oppoſition to compreſſion is proportional to a function of the area of the ſection.

As the whole length of a cylinder or priſm is equally preſſed, it does not appear that the ſtrength of a pillar is at all affected by its length. If indeed it be ſuppoſed to bend under the preſſure, the caſe is greatly changed, becauſe it is then expoſed to a tranſverſe ſtrain; and this increaſes with the length of the pillar. But this will be conſidered with due attention under the next claſs of ſtrains.

Few experiments have been made on this ſpecies of ſtrength and ſtrain. Mr Petit ſays, that his experiments and thoſe of Mr Parent, ſhow that the force neceſſary for cruſhing a body is nearly equal to that which will tear it aſunder. He ſays that it requires ſomething more than 60 pounds on every ſquare line to cruſh a piece of ſound oak. But the rule is by no means general: Glaſs, for inſtance, will carry a hundred times as much as oak in this way, that is, reſting on it; but will not *ſuſpend* above four or five times as much. Oak will ſuſpend a great deal more than fir; but fir will carry twice as much as a pillar. Woods of a ſoft texture, although conſiſting of very tenacious fibres, are more eaſily cruſhed by their load. This ſoftneſs of texture is chiefly owing to their fibres not being ſtraight but undulated, and there being conſiderable vacuities between them, ſo that they are eaſily bent laterally and cruſhed. When a poſt is overſtrained by its load, it is obſerved to ſwell ſenſibly in diameter. Increaſing the load cauſes longitudinal cracks or ſhivers to appear, and it preſently after gives way. This is called *crippling*.

In all caſes where the fibres lie oblique to the ſtrain the ſtrength is greatly diminiſhed, becauſe the parts can then be made to ſlide on each other, when the coheſion of the cementing matter is overcome.

Moſchenbroek has given ſome experiments on this ſubject; but they are caſes of long pillars, and therefore do not belong to this place. They will be conſidered afterwards.

The only experiments of which we have ſeen any detail (and it is uſeleſs to inſert mere aſſertions) are thoſe of Mr Gauthey, in the 4th volume of Rozier's *Journal de Phyſique*. This engineer expoſed to great preſſures ſmall rectangular parallelopipeds, cut from a great variety of ſtones, and noted the weights which cruſhed them. The following table exhibits the medium reſults of many trials on two very uniform kinds of freeſtone, one of them among the hardeſt and the other among the ſofteſt uſed in building.

Column 1ſt expreſſes the length AB of the ſection in French lines or 12ths of an inch; column 2d expreſſes the breadth BC; column 3d is the area of the ſection in ſquare lines; column 4th is the number of ounces required to cruſh the piece; column 5th is the weight which was then borne by each ſquare line of the ſection; and column 6th is the round numbers to which Mr Gauthey imagines that thoſe in column 5th approximate.

49 Experiments for this purpoſe made on freeſtone

	AB	BC	AB×BC	Weight	Force	
			Hard Stone.			
1	8	8	64	736	11.5	12
2	8	12	96	2625	27.3	24
3	8	16	128	4496	35.1	36
			Soft Stone.			
4	9	16	144	560	3.9	4
5	9	18	162	848	5.3	4.5
6	18	18	324	2928	9	9
7	18	24	432	5296	12.2	12

Little

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Little can be deduced from theſe experiments: The 1ſt and 3d, compared with the 5th and 6th, ſhould furniſh ſimilar reſults; for the 1ſt and 5th are reſpectively half of the 3d and 6th: but the 3d is three times ſtronger (that is, a line of the 3d) than the firſt, whereas the 6th is only twice as ſtrong as the 5th.

It is evident, however, that the ſtrength increaſes much faſter than the area of the ſection, and that a ſquare line can carry more and more weight, according as it makes a part of a larger and larger ſection. In the ſeries of experiments on the ſoft ſtone, the individual ſtrength of a ſquare line ſeems to increaſe nearly in the proportion of the ſection of which it makes a part.

Mr Gauthey deduces, from the whole of his numerous experiments, that a pillar of hard ſtone of Givry, whoſe ſection is a ſquare foot, will bear with perfect ſafety 664,000 pounds, and that its extreme ſtrength is 871,000, and the ſmalleſt ſtrength obſerved in any of his experiments was 460,000. The ſoft bed of Givry ſtone had for its ſmalleſt ſtrength 187,000, for its greateſt 311,000, and for its ſafe load 249,000. Good brick will carry with ſafety 320,000; chalk will carry only 9000. The boldeſt piece of architecture in this reſpect which he has ſeen is a pillar in the church of All-Saints at Angers. It is 24 feet long and 11 inches ſquare, and is loaded with 60,000, which is not one-ſeventh of what is neceſſary for cruſhing it.

We may obſerve here by the way, that Mr Gauthey's meaſure of the ſuſpending ſtrength of ſtone is vaſtly ſmall in proportion to its power of ſupporting a load laid above it. He finds that a priſm of the hard bed of Givry, of a foot ſection, is torn aſunder by 4600 pounds; and if
50 it be firmly fixed horizontally in a wall, it will be broken
not ſatisfactory. by a weight of 56,000 ſuſpended a foot from the wall. If it reſt on two props at a foot diſtance, it will be broken by 206,000 laid on its middle. Theſe experiments agree ſo ill with each other, that little uſe can be made of them. The ſubject is of great importance, and well
51 deſerves the attention of the patriotic philoſopher.

Good experiments much wanted. A ſet of good experiments would be very valuable, becauſe it is againſt this kind of ſtrain that we muſt guard by judicious conſtruction in the moſt delicate and difficult problems which come through the hands of the civil and military engineer. The conſtruction of ſtone arches, and the conſtruction of great wooden bridges, and particularly the conſtruction of the frames of carpentry called *centres* in the erection of ſtone bridges, are the moſt difficult jobs that occur. In the centres on which the arches of the bridge of Orleans were built ſome of the pieces of oak were carrying upwards of two tons on every ſquare inch of their ſcantling. All who ſaw it ſaid that it was not able to carry the fourth part of the intended load. But the engineer underſtood the principles of his art, and ran the riſk: and the reſult completely juſtified his confidence; for the centre did not complain in any part, only it was found too ſupple; ſo that it went out of ſhape while the haunches only of the arch were laid on it. The engineer corrected this by loading it at the crown, and thus kept it completely in ſhape during the progreſs of the work.

In the Memoirs (old) of the Academy of Peterſburgh for 1778, there is a diſſertation by Euler on this ſubject, but particularly limited to the ſtrain on columns, in which the bending is taken into the account. Mr Fuſs has treated the ſame ſubject with relation to carpentry in a ſubſequent volume. But there is little in theſe papers beſides a dry mathematical diſquiſition, proceeding on aſſumptions which (to ſpeak favourably) are extremely gratuitous. The moſt important conſequence of the compreſſion is wholly overlooked, as we ſhall preſently ſee. Our knowledge of the mechaniſm of coheſion is as yet far too imperfect to entitle us to a confident application of mathematics. Experiments ſhould be multiplied.

52 How they are to be made uſeful.

The only way we can hope to make theſe experiments uſeful is to pay a careful attention to the *manner* in which the fracture is produced. By diſcovering the general reſemblances in this particular, we advance a ſtep in our power of introducing mathematical meaſurement. Thus, when a cubical piece of chalk is ſlowly cruſhed between the chaps of a vice, we ſee it uniformly ſplit in a ſurface oblique to the preſſure, and the two parts then ſlide along the ſurface of fracture. This ſhould lead us to examine mathematically what relation there is between this ſurface of fracture and the neceſſary force; then we ſhould endeavour to determine experimentally the poſition of this ſurface. Having diſcovered ſome general law or reſemblance in this circumſtance, we ſhould try what mathematical hypotheſis will agree with this. Having found one, we may then apply our ſimpleſt notions of coheſion, and compare the reſult of our computations with experiment. We are authoriſed to ſay, that a ſeries of experiments have been made in this way, and that their reſults have been very uniform, and therefore ſatisfactory, and that they will ſoon be laid before the public as the foundations of ſucceſsful practice in the conſtruction of arches.

III. A Body may be broken across.

53 It is of importance to know what ſtrain will break a body tranſverſely.

The moſt uſual, and the greateſt ſtrain, to which materials are expoſed, is that which tends to break them tranſverſely. It is ſeldom, however, that this is done in a manner perfectly ſimple; for when a beam projects horizontally from a wall, and a weight is ſuſpended from its extremity, the beam is commonly broken near the wall, and the intermediate part has performed the functions of a lever. It ſometimes, though rarely, happens that the pin in the joint of a pair of pincers or ſciſſars is cut through by the ſtrain; and this is almoſt the only caſe of a ſimple tranſverſe fracture. Being ſo rare, we may content ourſelves with ſaying, that in this caſe the ſtrength of the piece is proportional to the area of the ſection.

54 Experiments made to aſcertain it.

Experiments were made for diſcovering the reſiſtances made by bodies to this kind of ſtrain in the following manner: Two iron bars were diſpoſed horizontally at an inch diſtance; a third hung perpendicularly between them, being ſupported by a pin made of the ſubſtance to be examined. This pin was made of a priſmatic form, ſo as to fit exactly the holes in the three bars, which were made very exact, and of the ſame ſize and ſhape. A ſcale was ſuſpended at the lower end of the perpendicular bar, and loaded till it tore out that part of the pin which filled the middle hole. This weight was evidently the meaſure of the lateral coheſion of two ſections. The ſide-bars were made to graſp the middle bar pretty ſtrongly between them, that there might be no diſtance impoſed between the oppoſite preſſures. This would have combined the energy of a lever with the purely tranſverſe preſſure. For the ſame reaſon it was neceſ-

ſary

Strength of Materials. sary that the internal parts of the holes should be no smaller than the edges. Great irregularities occurred in our first experiments from this cause, because the pins were somewhat tighter within than at the edges; but when this was corrected they were extremely regular. We employed three sets of holes, viz. a circle, a square (which was occasionally made a rectangle whose length was twice its breadth), and an equilateral triangle. We found in all our experiments the strength exactly proportional to the area of the section, and quite independent of its figure or position, and we found it considerably above the direct cohesion; that is, it took considerably more than twice the force to tear out this middle piece than to tear the pin asunder by a direct pull. A piece of fine freestone required 205 pounds to pull it directly asunder, and 575 to break it in this way. The difference was very constant in any one substance, but varied from four-thirds to six-thirds in different kinds of matter, being smallest in bodies of a fibrous texture. But indeed we could not make the trial on any bodies of considerable cohesion, because they required such forces as our apparatus could not support. Chalk, clay baked in the sun, baked sugar, brick, and freestone, were the strongest that we could examine.

55 Their result.

But the more common case, where the energy of a lever intervenes, demands a minute examination.

56 The strength of a lever. Fig. 5.

Let DABC (fig. 5.) be a vertical section of a prismatic solid (that is, of equal size throughout), projecting horizontally from a wall in which it is firmly fixed; and let a weight P be hung on it at B, or let any power P act at B in a direction perpendicular to AB. Suppose the body of insuperable strength in every part except in the vertical section DA, perpendicular to its length. It must break in this section only. Let the cohesion be uniform over the whole of this section; that is, let each of the adjoining particles of the two parts cohere with an equal force f.

There are two ways in which it may break. The part ABCD may simply slide down along the surface of fracture, provided that the power acting at B is equal to the accumulated force which is exerted by every particle of the section in the direction AD.

But suppose this effectually prevented by something that supports the point A. The action at P tends to make the body turn round A (or round a horizontal line passing through A at right angles to AB) as round a joint. This it cannot do without separating at the line DA. In this case the adjoining particles at D or at E will be separated horizontally. But their cohesion resists this separation. In order, therefore, that the fracture may happen, the energy or momentum of the power P, acting by means of the lever AB, must be superior to the accumulated energies of the particles. The energy of each depends not only on its cohesive force, but also on its situation; for the supposed insuperable firmness of the rest of the body makes it a lever turning round the fulcrum A, and the cohesion of each particle, such as D or E, acts by means of the arm DA or EA. The energy of each particle will therefore be had by multiplying the force exerted by it in the instant of fracture by the arm of the lever by which it acts.

Let us therefore first suppose, that in the instant of fracture every particle is exerting an equal force f. The energy of D will be $f \times$ DA, and that of E will be $f \times$ EA, and that of the whole will be the sum of all these products. Let the depth DA of the section be called d, and let any undetermined part of it EA be called x, and then the space occupied by any particle will be $\dot{x}$. The cohesion of this space may be represented by $f\dot{x}$, and that of the whole by fd. The energy by which each element $\dot{x}$ of the line DA, or d, resists the fracture, will be $fx\dot{x}$, and the whole accumulated energies will be $f \times \int x\dot{x}$. This we know to be $f \times \frac{1}{2}d^2$, or $fd \times \frac{1}{2}d$. It is the same therefore as if the cohesion fd of the whole section had been acting at the point G, which is the middle of DA.

The reader who is not familiarly acquainted with this fluxionary calculus may arrive at the same conclusion in another way. Suppose the beam, instead of projecting horizontally from a wall, to be hanging from the ceiling, in which it is firmly fixed. Let us consider how the equal cohesion of every part operates in hindering the lower part from separating from the upper by opening round the joint A. The equal cohesion operates just as equal gravity would do, but in the opposite direction. Now we know, by the most elementary mechanics, that the effect of this will be the same as if the whole weight were concentrated in the centre of gravity G of the line DA, and that this point G is in the middle of DA. Now the number of fibres being as the length d of the line, and the cohesion of each fibre being $=f$, the cohesion of the whole line is $f \times d$ or fd.

The accumulated energy therefore of the cohesion in the instant of fracture is $fd \times \frac{1}{2}d$. Now this must be equal or just inferior to the energy of the power employed to break it. Let the length AB be called l; then $P \times l$ is the corresponding energy of the power. This gives us $fd\frac{1}{2}d = pl$ for the equation of equilibrium corresponding to the vertical section ADCB.

Suppose now that the fracture is not permitted at DA, but at another section $\delta\alpha$ more remote from B. The body being prismatic, all the vertical sections are equal; and therefore $fd\frac{1}{2}d$ is the same as before. But the energy of the power is by this means increased, being now $= P \times B\alpha$, instead of $P \times BA$: Hence we see that when the prismatic body is not insuperably strong in all its parts, but equally strong throughout, it must break close at the wall, where the strain or energy of the power is greatest. We see, too, that a power which is just able to break it at the wall is unable to break it anywhere else; also an absolute cohesion fd, which can withstand the power p in the section DA, will not withstand it in the section $\delta\alpha$, and will withstand more in the section $d'a'$.

This teaches us to distinguish between absolute and relative strength. The relative strength of a section has a reference to the strain actually exerted on that section. This relative strength is properly measured by the power which is just able to balance or overcome it, when applied at its proper place. Now since we had $fd\frac{1}{2}d = pl$, we have $p = \frac{fd\frac{1}{2}d}{l}$ for the measure of the strength of the section of the section DA, in relation to the power applied at B.

If the solid is a rectangular beam, whose breadth is b, it is plain that all the vertical sections are equal, and that AG or $\frac{1}{2}d$ is the same in all. Therefore the equa-

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tion expressing the equilibrium between the momentum of the external force and the accumulated momenta of cohesion will be $p\,l = f\,d\,b \times \frac{1}{2}d$.

The product $d\,b$ evidently expresses the area of the section of fracture, which we may call s, and we may express the equilibrium thus, $p\,l = f\,s\,\frac{1}{2}d$, and $2\,l : d = f\,s : p$.

Now $f\,s$ is a proper expression of the absolute cohesion of the section of fracture, and p is a proper measure of its strength in relation to a power applied at B. We may therefore say, that *twice the length of a rectangular beam is to the depth as the absolute cohesion to the relative strength.*

Since the action of equable cohesion is similar to the action of equal gravity, it follows, that whatever is the figure of the section, the relative strength will be the same as if the absolute cohesion of all the fibres were acting at the centre of gravity of the section. Let g be the distance between the centre of gravity of the section and the axis of fracture, we shall have $p\,l = f\,s\,g$, and $l : g = f\,s : p$. It will be very useful to recollect this analogy in words: "*The length of a prismatic beam of any shape is to the height of the centre of gravity above the lower side, as the absolute cohesion to the strength relative to this length.*"

Because the relative strength of a rectangular beam is $\frac{f\,b\,d\,\frac{1}{2}d}{l}$ or $\frac{f\,b\,d^2}{2\,l}$, it follows, that the relative strengths of different beams are proportional to the absolute cohesion of the particles, to the breadth, and to the square of the depth directly, and to the length inversely; also in prisms whose sections are similar, the strengths are as the cubes of the diameters.

57 Ascertained on the hypothesis of equal cohesion;

Such are the more general results of the mechanism of this transverse strain, in the hypothesis that all the particles are exerting equal forces in the instant of fracture. We are indebted for this doctrine to the celebrated Galileo; and it was one of the first specimens of the application of mathematics to the science of nature.

We have not included in the preceding investigation that action of the external force by which the solid is drawn sidewise, or tends to slide along the surface of fracture. We have supposed a particle E to be pulled only in the direction E e, perpendicular to the section of fracture, by the action of the crooked lever BAE. But it is also pulled in the direction EA; and its reaction is in some direction ϵ E, compounded of ϵf, by which it resists being pulled outwards; and $\epsilon\,e$ by which it resists being pulled downwards. We are but imperfectly acquainted with the force $\epsilon\,e$, and only know that their accumulated sum is equal to the force p; but in all important cases which occur in practice, it is unnecessary to attend to this force; because it is so small in comparison of the forces in the direction Ee, as we easily conclude from the usual smallness of AD in comparison of AB.

58 but that hypothesis not conformable to nature.

The hypothesis of equal cohesion, exerted by all the particles in the instant of fracture, is not conformable to nature: for we know, that when a force is applied transversely at B, the beam is bent downwards, becoming convex on the upper side; that side is therefore on the stretch. The particles at D are farther removed from each other than those at E, and are therefore *actually exerting* greater cohesive forces. We cannot say with certainty and precision in what proportion each fibre is extended. It seems most probable that the extensions are proportional to the distances from A. We shall suppose this to be really the case. Now recollect the general law which we formerly said was *observed* in all moderate extensions, *viz.* that the attractive forces exerted by the dilated particles were proportional to their dilatations. Suppose now that the beam is so much bent that the particles at D are exerting their utmost force, and that this fibre is just ready to break or actually breaks. It is plain that a total fracture must immediately ensue; because the force which was superior to the full cohesion of the particle at D, and a certain portion of the cohesion of all the rest, will be more than superior to the full cohesion of the particle next within D, and a smaller portion of the cohesion of the remainder.

Now let F represent, as before, the full force of the exterior fibre D, which is exerted by it in the instant of its breaking, and then the force exerted at the same instant by the fibre E will be had by this analogy, AD : AE, or $d : x = f : \frac{f\,x}{d}$, and the force really exerted by the fibre E is $f \times \frac{x}{d}$.

The force exerted by a fibre whose thickness is $\dot{x}$ is therefore $\frac{f\,x\,\dot{x}}{d}$; but this force resists the strain by acting by means of the lever EA or x. Its energy or momentum is therefore $\frac{f\,x^2\,\dot{x}}{d}$, and the accumulated momenta of all the fibres in the line AE will be $f \times$ sum of $\frac{x^2\,\dot{x}}{d}$. This, when x is taken equal to d, will express the momentum of the whole fibres in the line AD. This, therefore, is $f\frac{\frac{1}{3}d^3}{d}$, or $f\,\frac{1}{3}\,d^2$, or $f\,d \times \frac{1}{3}\,d$. Now $f\,d$ expresses the absolute cohesion of the whole line AD. The accumulated momentum is therefore the same as if the absolute cohesion of the whole line were exerted at one-third of AD from A.

From these premises it follows that the equation expressing the equilibrium of the strain and cohesion is $p\,l = f\,d \times \frac{1}{3}\,d$; and hence we deduce the analogy, "*As thrice the length is to the depth, so is the absolute cohesion to the relative strength.*" 59 The strength ascertained on other principles.

This equation and this proportion will equally apply to rectangular beams whose breadth is b; for we shall then have $p\,l = f\,b\,d \times \frac{1}{3}\,d$.

We also see that the relative strength is proportional to the absolute cohesion of the particles, to the breadth, and to the square of the depth directly, and to the length inversely: for p is the measure of the force with which it is resisted, and $p = \frac{f\,b\,d\,\frac{1}{3}\,d}{l}, = \frac{f\,b\,d^2}{3\,l}$. In this respect therefore this hypothesis agrees with the Galilean; but it assigns to every beam a smaller proportion of the absolute cohesion of the section of fracture, in the proportion of three to two. In the Galilean hypothesis this section has a momentum equal to one-half of its absolute strength, but in the other hypothesis it is only one-third. In beams of a different form the proportion may be different.

As this is a most important proposition, and the foundation cation of many practical maxims, we are anxious to have it clearly comprehended, and its evidence perceived by all. Our better informed readers will therefore indulge us while we endeavour to preſent it in another point of view, where it will be better ſeen by thoſe who are not familiarly acquainted with the fluxionary calculus.

60 The ſame propoſition preſented in another point of view. Fig. 6.

Fig. 6. A is a perſpective view of a three-ſided beam projecting horizontally from a wall, and loaded with a weight at B juſt ſufficient to break it. DABC is a vertical plane through its higheſt point D, in the direction of its length. a D a is another vertical ſection perpendicular to AB. The piece being ſuppoſed of inſuperable ſtrength everywhere except in the ſection a D a, and the coheſion being alſo ſuppoſed inſuperable along the line a A a, it can break nowhere but in this ſection, and by turning round a A a as round a hinge. Make D d equal to AD, and let D d repreſent the abſolute coheſion of the fibre at D, which abſolute coheſion we expreſſed by the ſymbol f. Let a plane $a\,d\,a$ be made to paſs through $a\,a$ and d, and let $d\,a'\,a'$ be another croſs ſection. It is plain that the priſmatic ſolid contained between the two ſections a D a and $a'\,d\,a'$ will repreſent the full coheſion of the whole ſection of fracture; for we may conceive this priſm as made up of lines ſuch as Ff, equal and parallel to D d, repreſenting the abſolute coheſion of each particle ſuch as F. The pyramidal ſolid d D $a\,a$, cut off by the plane $d\,a\,a$, will repreſent the coheſions *actually exerted* by the different fibres in the inſtant of fracture. For take any point E in the ſurface of fracture, and draw E e parallel to AB, meeting the plane $a\,d\,a$ in e, and let e AE be a vertical plane. It is evident that D d is to E e as AD to AE; and therefore (ſince the forces exerted by the different fibres are as their extenſion, and their extenſion as their diſtances from the axis of fracture) E e will repreſent the force actually exerted by the fibre in E, while D is exertiṡg its full force D d. In like manner, the plane FFff expreſſes the coheſion exerted by all the fibres in the line FF, and ſo on through the whole ſurface. Therefore the pyramid $d\,a\,a$ D expreſſes the accumulated exertion of the whole ſurface of fracture.

Farther, ſuppoſe the beam to be held perpendicular to the horizon with the end B uppermoſt, and that the weight of the priſm contained between the two ſections a D a and $a'\,d\,a'$ (now horizontal) is juſt able to overcome the full coheſion of the ſection of fracture. The weight of the pyramid d D $a\,a$ will alſo be juſt able to overcome the coheſions *actually exerted* by the different fibres in the inſtant of fracture, becauſe the weight of each fibre, ſuch as E e, is juſt ſuperior to the coheſion actually exerted at E.

Let o be the centre of gravity of the pyramidal ſolid, and draw o O perpendicular to the plane a D a. The whole weight of the ſolid dD $a\,a$ may be conceived as accumulated in the point o, and as acting on the point O, and it will have the ſame tendency to ſeparate the two cohering ſurfaces as when each fibre is hanging by its reſpective point. For this reaſon the point O may be called the *centre of actual effort* of the unequal forces of coheſion. The momentum therefore, or energy by which the cohering ſurfaces are ſeparated, will be properly meaſured by the weight of the ſolid d D $a\,a$ multiplied by OA; and this product is equal to the product of the weight p multiplied by BA, or by l. Thus ſuppoſe that the coheſion along the line AD only is conſidered. The whole coheſion will be repreſented by a triangle AD d. D d repreſents f, and AD is d, and AD is x. Therefore AD d is $\frac{1}{2} f d$. The centre of gravity o of the triangle AD d is in the interſection of a line drawn from A to the middle of D d with a line drawn from d to the middle of AD; and therefore the line o O will make AO$=\frac{2}{3}$ of AD. Therefore the actual momentum of coheſion is $f \times \frac{1}{2} d \times \frac{2}{3} d, = f \times d \times \frac{1}{3} d, = f d \times \frac{1}{3} d$, or equal to the abſolute coheſion acting by means of the lever $\dfrac{d}{3}$. If the ſection of fracture is a rectangle, as in a common joiſt, whoſe breadth $a\,a$ is $= b$, it is plain that all the vertical lines will be repreſented by triangles like AD d; and the whole actual coheſion will be repreſented by a wedge whoſe baſes are vertical planes, and which is equal to half of the parallelopiped AD$\times$D $d \times a\,a$, and will therefore be $= \frac{1}{2} f b d$; and the diſtance AO of its centre of gravity from the horizontal line AA$'$ will be $\frac{2}{3}$ of AD. The momentum of coheſion of a joiſt will therefore be $\frac{1}{2} f b d \times \frac{2}{3} d$, or $f b d \frac{1}{3} d$, as we have determined in the other way.

The beam repreſented in the figure is a triangular priſm. The pyramid D$a\,a\,d$ is $\frac{1}{3}$ of the priſm $a\,a$D$d\,a'a'$. If we make s repreſent the ſurface of the triangle a D a, the pyramid is $\frac{1}{3}$ of $f s$. The diſtance AO of its centre of gravity from the horizontal line AA$'$ is $\frac{1}{2}$ of AD, or $\frac{1}{2} d$. Therefore the momentum of actual coheſion is $\frac{1}{3} f s \times \frac{1}{2} d, = f s \frac{1}{6} d$; that is, it is the ſame as if the full coheſion of all the fibres were accumulated at a point I whoſe diſtance from A is $\frac{1}{6}$th of AD or d; or (that we may ſee its value in every point of view) it is $\frac{1}{6}$th of the momentum of the full coheſion of all the fibres when accumulated at the point D, or acting at the diſtance d=AD.

This is a very convenient way of conceiving the momentum of actual coheſion, by comparing it with the momentum of abſolute coheſion applied at the diſtance AD from the axis of fracture. The momentum of the abſolute coheſion applied at D is to the momentum of actual coheſion in the inſtant of fracture as AD to AI. Therefore the length of AI, or its proportion to AD, is a ſort of index of the ſtrength of the beam. We ſhall call it the Index, and expreſs it by the ſymbol i.

Its value is eaſily obtained. The product of the abſolute coheſion by AI muſt be equal to that of the actual coheſion by AO. Therefore ſay, "as the priſmatic ſolid $a\,a$ D $d\,a'\,a'$ is to the pyramidal ſolid $a\,a$ D d, ſo is AO to AI." We are aſſiſted in this determination by a very convenient circumſtance. In this hypotheſis of the actual coheſions being as the diſtances of the fibres from A, the point O is the centre of oſcillation or percuſſion of the ſurface D $a\,a$ turning round the axis $a\,a$: for the momentum of coheſion of the line FF is FF$\times$F$f\times$EA$=$FF$\times$EA^2, becauſe Ff is equal to EA. Now AO, by the nature of the centre of gravity, is equal to the ſum of all theſe momenta divided by the pyramid $a\,a$ Dd; that is, by the ſum of all the FF$\times$Ff; that is, by the ſum of all the FF$\times$EA.

Therefore $\text{AO}=\dfrac{\text{ſum of FF}\times\text{EA}^2}{\text{ſum of FF}\times\text{EA}}$, which is juſt the value of the diſtance of the centre of percuſſion of the triangle $a\,a$ D from A: (See Rotation). Moreover, if

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if G be the centre of gravity of the triangle a D a, we shall have DA to GA as the absolute cohesion to the sum of the cohesions actually exerted in the instant of fracture; for, by the nature of this centre of gravity, AG is equal to $\frac{\text{sum of FF} \times \text{EA}}{\text{sum of FF}}$, and the sum of FF $\times$ AG is equal to the sum of FF $\times$ EA. But the sum of all the lines FF is the triangle a D a, and the sum of all the FF $\times$ EA is the sum of all the rectangles FFff; that is, the pyramid dD $a\,a$. Therefore a prism whose base is the triangle a D a, and whose height is AG, is equal to the pyramid, or will express the sum of the actual cohesions; and a prism, whose base is the same triangle, and whose height is D d or D a, expresses the absolute cohesion. Therefore DA is to GA as the absolute cohesion to the sum of the actual cohesions.

Therefore we have DA : GA = OA : IA.

Therefore, whatever be the form of the beam, that is, whatever be the figure of its section, find the centre of oscillation O, and the centre of gravity G of this section. Call their distances from the axis of fracture o and g. Then AI or $i = \frac{o\,g}{d}$, and the momentum of cohesion is $f s \times \frac{o\,g}{d}$, where s is the area of fracture.

This index is easily determined in all the cases which generally occur in practice. In a rectangular beam AI is $\frac{2}{3}$d of AD; in a cylinder (circular or elliptic) AI is $\frac{5}{8}$ths of AD, &c. &c.

In this hypothesis, that the cohesion actually exerted by each fibre is as its extension, and that the extensions of the fibres are as their distances from A (fig. 5.), it is plain that the forces exerted by the fibres D, E, &c. will be represented by the ordinates Dd, E e, &c. to a straight line A d. And we learn from the principles of ROTATION that the centre of percussion O is in the ordinate which passes through the centre of gravity of the triangle AD d, or (if we consider the whole section having breadth as well as depth) through the centre of gravity of the solid bounded by the planes DA, d A; and we found that this point O was the centre of effort of the cohesions *actually* exerted in the instant of fracture, and that I was the centre of an *equal* momentum, which would be produced if all the fibres were accumulated there and exerted their *full* cohesion.

This consideration enables us to determine, with equal facility and neatness, the strength of a beam in any hypothesis of forces. The above hypothesis was introduced with a cautious limitation to moderate strains, which produced no permanent change of form, or no sett as the artists call it: and this suffices for all purposes of practice, seeing that it would be imprudent to expose materials to more violent strains. But when we compare this theory with experiments in which the pieces are really broken, considerable deviations may be expected, because it is very probable that in the vicinity of rupture the forces are no longer proportional to the extensions.

61 How the relative strength may be determined by any other hypothesis.

That no doubt may remain as to the justness and completeness of the theory, we must show how the relative strength may be determined in any other hypothesis. Therefore suppose that it has been established by experiment on any kind of solid matter, that the forces actually exerted in the instant of fracture by the fibres at D, E, &c. are as the ordinates D d', E e', &c. of any curve line A e' d'. We are supposed to know the form of this curve, and that of the solid which is bounded by the vertical plane through AD, and by the surface which passes through this curve A e' d' perpendicularly to the length of the beam. We know the place of the centre of gravity of this curve surface or solid, and can draw a line through it parallel to AB, and cutting the surface of fracture in some point O. This point is also the centre of effort of all the cohesions actually exerted; and the product of AO and of the solid which expresses the actual cohesions will give the momentum of cohesion equivalent to the former $f s \frac{o\,g}{d}$. Or we may find an index AI, by making AI a fourth proportional to the full cohesion of the surface of fracture, to the accumulated actual cohesions, and to AO; and then $f s \times i$ (=AI) will be the momentum of cohesion; and we shall still have I for the point in which all the fibres may be supposed to exert their full cohesion f, and to produce a momentum of cohesion equal to the real momentum of the cohesions actually exerted, and the relative strength of the beam will still be $p = \frac{f s i}{l}$ or $\frac{f s g o}{d l}$. Thus, if the forces be as the squares of the extensions (still supposed to be as the distances from A), the curve A e' d' will be a common parabola, having AB for its axis and AD for the tangent at its vertex. The area AD d' will be $\frac{1}{3}$d AD $\times$ D d; and in the case of a rectangular beam, AO will be $\frac{3}{4}$ths AD, and AI will be $\frac{1}{4}$th of AD.

We may observe here in general, that if the forces actually exerted in the instant of fracture be as any power q of the distance from A, the index AI will be $= \frac{\text{AD}}{q+2}$ for a rectangular beam, and the momentum of cohesion will always be *(cæteris paribus)* as the breadth and as the square of the depth; nay, this will be the case whenever the action of the fibres D and E is expressed by any *similar functions* of d and x. This is evident to every reader acquainted with the fluxionary calculus.

As far as we can judge from experience, no simple algebraic power of the distance will express the actual cohesions of the fibres. No curve which has either AD or AB for its tangent will suit. The observations which we made in the beginning show, that although the curve of fig. 2. must be sensibly straight in the vicinity of the points of intersection with the axis, in order to agree with our observations which show the moderate extensions to be as the extending forces, the curve *must* be concave towards the axis in all its attractive branches, because it cuts it again. Therefore the curve A e' d' of fig. 5. must make a finite angle with AD or AB, and it must, in all probability, be also concave towards AD in the neighbourhood of d'. It may however be convex in some part of the intermediate arch. We have made experiments on the extensions of different bodies, and find great diversities in this respect: But in all, the moderate extensions were as the forces, and this with great accuracy till the body took a sett, and remained longer than formerly when the extending force was removed.

We must now remark, that this correction of the Galilean hypothesis of equal forces was suggested by the bending

bending which is obſerved in all bodies which are ſtrained tranſverſely. Becauſe they are bent, the fibres on the convex ſide have been extended. We cannot ſay in what proportion this obtains in the different fibres. Our moſt diſtinct notions of the internal equilibrium between the particles render it highly probable that their extenſion is proportional to their diſtance from that fibre which retains its former dimenſions. But by whatever law this is regulated, we ſee plainly that the actions of the ſtretched fibres muſt follow the proportions of ſome function of this diſtance, and that therefore the relative ſtrength of a beam is in all caſes ſuſceptible of mathematical determination.

62 Bernoulli's problem of the elaſtic curve.

We alſo ſee an intimate connection between the ſtrain and the curvature. This ſuggeſted to the celebrated James Bernoulli the problem of the ELASTIC CURVE, i. e. the curve into which an extenſible rigid body will be bent by a tranſverſe ſtrain. His ſolution in the *Acta Lipſiæ* 1694 and 1695 is a very beautiful ſpecimen of mathematical diſcuſſion; and we recommend it to the peruſal of the curious reader, He will find it very perſpicuouſly treated in the firſt volume of his works, publiſhed after his death, where the wide ſteps which he had taken in his inveſtigation are explained ſo as to be eaſily comprehended. His nephew Daniel Bernoulli has given an elegant abridgement in the Peterſburg Memoirs for 1729. The problem is too intricate to be fully diſcuſſed in a work like ours; but it is alſo too intimately connected with our preſent ſubject to be entirely omitted. We muſt content ourſelves with ſhowing the leading mechanical properties of this curve, from which the mathematician may deduce all its geometrical properties.

63 Its leading mechanical property deſcribed.

When a bar of uniform depth and breadth, and of a given length, is bent into an arch of a circle, the extenſion of the outer fibres is proportional to the curvature; for, becauſe the curves formed by the inner and outer ſides of the beam are ſimilar, the circumferences are as the radii, and the radius of the inner circle is to the difference of the radii as the length of the inner circumference is to the difference of the circumferences. The difference of the radii is the depth of the beam, the difference of the circumferences is the extenſion of the outer fibres, and the inner circumference is ſuppoſed to be the primitive length of the beam. Now the ſecond and third quantities of the above analogy, viz. the depth and length of the beam, are conſtant quantities, as is alſo their product. Therefore the product of the inner radius and the extenſion of the outer fibre is alſo a conſtant quantity, and the whole extenſion of the outer fibre is inverſely as the radius of curvature, or is directly as the curvature of the beam.

The mathematical reader will readily ſee, that into whatever curve the elaſtic bar is bent, the whole extenſion of the outer fibre is equal to the length of a ſimilar curve, having the ſame proportion to the thickneſs of the beam that the length of the beam has to the radius of curvature.

Fig. 7.

Now let ADCB (fig. 7.) be ſuch a rod, of uniform breadth and thickneſs, firmly fixed in a vertical poſition, and bent into a curve AEFB by a weight W ſuſpended at B, and of ſuch magnitude that the extremity B has its tangent perpendicular to the action of the weight, or parallel to the horizon. Suppoſe too that the extenſions are proportional to the extending forces. From any two points E and F draw the horizontal ordinates EG, FH. It is evident that the exterior fibres of the ſections E *e* and F *f* are ſtretched by forces which are in the proportion of EG to FH (theſe being the long arms of the levers, and the equal thickneſſes E *e*, F *f* being the ſhort arms). Therefore (by the hypotheſis) their extenſions are in the ſame proportion. But becauſe the extenſions are proportional to ſome ſimilar functions of the diſtance from the axes of fracture E and F, the extenſion of any fibre in the ſection E *e* is to the contemporaneous extenſion of the ſimilarly ſituated fibre in the ſection F *f*, as the extenſion of the exterior fibre in the ſection E *e* is to the extenſion of the exterior fibre in the ſection F *f*: therefore the whole extenſion of E *e* is to the whole extenſion of F *f* as EG to FH, and EG is to FH as the curvature in E to the curvature in F.

Here let it be remarked, that this proportionality of the curvature to the extenſion of the fibres is not limited to the hypotheſis of the proportionality of the extenſions to the extending forces. It follows from the extenſion in the different ſections being as ſome ſimilar function of the diſtance from the axis of fracture; an aſſumption which cannot be refuſed.

This then is the fundamental property of the elaſtic curve, from which its equation, or relation between the abſciſſa and ordinate, may be deduced in the uſual forms, and all its other geometrical properties. Theſe are foreign to our purpoſe; and we ſhall notice only ſuch properties as have an immediate relation to the ſtrain and ſtrength of the different parts of a flexible body, and which in particular ſerve to explain ſome difficulties in the valuable experiments of M. Buffon on the Strength of Beams.

64 It is not a circle.

We obſerve, in the firſt place, that the elaſtic curve cannot be a circle, but is gradually more incurvated as it recedes from the point of application B of the ſtraining forces. At B it has no curvature; and if the bar were extended beyond B there would be no curvature there. In like manner, when a beam is ſupported at the ends and loaded in the middle, the curvature is greateſt in the middle; but at the props, or beyond them, if the beam extend farther, there is no curvature. Therefore when a beam projecting 20 feet from a wall is bent to a certain curvature at the wall by a weight ſuſpended at the end, and a beam of the ſame ſize projecting 20 feet is bent to the very ſame curvature at the wall by a greater weight at 10 feet diſtance, the figure and the mechanical ſtate of the beam in the vicinity of the wall is different in theſe two caſes, though the curvature at the very wall is the ſame in both. In the firſt caſe every part of the beam is incurvated; in the ſecond, all beyond the 10 feet is without curvature. In the firſt experiment the curvature at the diſtance of five feet from the wall is three-fourths of the curvature at the wall; in the ſecond, the curvature at the ſame place is but one-half of that at the wall. This muſt weaken the long beam in this whole interval of five feet, becauſe the greater curvature is the reſult of a greater extenſion of the fibres.

65 Every beam has a certain determinate curvature.

In the next place, we may remark, that there is a certain determinate curvature for every beam which cannot be exceeded without breaking it; for there is a certain ſeparation of two adjoining particles that puts an end to their coheſion. A fibre can therefore

be

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be extended only a certain proportion of its length. The ultimate extenſion of the outer fibres muſt bear a certain determinate proportion to its length, and this proportion is the ſame with that of the thickneſs (or what we have hitherto called the depth) to the radius of ultimate curvature, which is therefore determinate.

66
And when of uniform breadth and depth is moſt incurvated where the ſtrain is greateſt.

A beam of uniform breadth and depth is therefore moſt incurvated where the ſtrain is greateſt, and will break in the moſt incurvated part. But by changing its form, ſo as to make the ſtrength of its different ſections in the ratio of the ſtrain, is is evident that the curvature may be the ſame throughout, or may be made to vary according to any law. This is a remark worthy of the attention of the watchmaker. The moſt delicate problem in practical mechanics is ſo to taper the balance-ſpring of a watch that its wide and narrow vibrations may be iſochronous. Hooke's principle *ut tenſio ſic vis* is not ſufficient when we take the *inertia* and motion of the ſpring itſelf into the account. The figure into which it bends and unbends has alſo an influence. Our readers will take notice that the artiſt aims at an accuracy which will not admit an error of $\frac{1}{86400}$th, and that Harriſon and Arnold have actually attained it in ſeveral inſtances. The taper of a ſpring is at preſent a noſtrum in the hands of each artiſt, and he is careful not to impart his ſecret.

Again, ſince the depth of the beam is thus proportional to the radius of ultimate curvature, this ultimate or breaking curvature is inverſely as the depth. It may be expreſſed by $\frac{1}{d}$.

67
To what the curvature is proportional.

When a weight is hung on the end of a priſmatic beam, the curvature is nearly as the weight and the length directly, and as the breadth and the cube of the depth inverſely; for the ſtrength is $= f\frac{b\,d^2}{3\,l}$. Let us ſuppoſe that this produces the ultimate curvature $\frac{1}{d}$. Now let the beam be loaded with a ſmaller weight w, and let the curvature produced be C, we have this analogy $f\frac{b\,d^2}{3\,l} : w = \frac{1}{d} : \mathrm{C}$, and $\mathrm{C} = \frac{3\,l\,w}{f\,b\,d^3}$. It is evident that this is alſo true of a beam ſupported at the ends and loaded between the props; and we ſee how to determine the curvature in its different parts, whether ariſing from the load, or from its own weight, or from both.

When a beam is thus loaded at the end or middle, the loaded point is pulled down, and the ſpace through which it is drawn may be called the DEFLECTION. This

68
Deflection.

may be conſidered as the ſubtenſe of the angle of contact, or as the verſed ſine of the arch into which the beam is bent, and is therefore as the curvature when the length of the arches is given (the flexure being moderate), and as the ſquare of the length of the arch when the curvature is given. The deflection therefore is as the curvature and as the ſquare of the length of the arch jointly; that is, as $\frac{3\,l\,w}{f\,b\,d^3}\times l^2$, or as $\frac{3\,l^3 w}{f\,b\,d^3}$. The deflection from the primitive ſhape is therefore as the bending weight and the cube of the length directly, and as the breadth and cube of the depth inverſely.

In beams juſt ready to break, the curvature is as the depth inverſely, and the deflection is as the ſquare of the length divided by the depth; for the ultimate curvature at the breaking part is the ſame whatever is the length; and in this caſe the deflection is as the ſquare of the length.

69
The theorems reſulting from this ſubject afford the fineſt methods of examining the laws of corpuſcular action.

We have been the more particular in our conſideration of this ſubject, becauſe the reſulting theorems afford us the fineſt methods of examining the laws of corpuſcular action, that is, for diſcovering the variation of the force of coheſion by a change of diſtance. It is true it is not the atomical law, or HYLARCHIC PRINCIPLE as it may juſtly be called, which is thus made acceſſible, but the ſpecific law of the particles of the ſubſtance or kind of matter under examination. But even this is a very great point; and coincidences in this reſpect among the different kinds of matter are of great moment. We may thus learn the nature of the corpuſcular action of different ſubſtances, and perhaps approach to a diſcovery of the *mechaniſm* of chemical affinities. For that chemical actions are inſenſible caſes of local motion is undeniable, and local motion is the province of mechanical diſcuſſion; nay, we ſee that theſe hidden changes are produced by mechanical forces in many important caſes, for we ſee them promoted or prevented by means purely mechanical. The converſion of bodies into elaſtic vapour by heat can at all times be prevented by a *ſufficient* external preſſure. A ſtrong ſolution of Glauber's ſalt will congeal in an inſtant by agitation, giving out its latent heat; and it will remain fluid for ever, and return its latent heat in a cloſe veſſel which it completely fills. Even water will by ſuch treatment freeze in an inſtant by agitation, or remain fluid for ever by confinement. We know that heat is produced or extricated by friction, that certain compounds of gold or ſilver with ſaline matters explode with irreſiſtible violence by the ſmalleſt preſſure or agitation. Such facts ſhould rouſe the mathematical philoſopher, and excite him to follow out the conjectures of the illuſtrious Newton, encouraged by the ingenious attempts of Boſcovich; and the proper beginning of this ſtudy is to attend to the laws of attraction and repulſion exerted by the particles of cohering bodies, diſcoverable by experiments made on their actual extenſions and compreſſions. The experiments of ſimple extenſions and compreſſions are quite inſufficient, becauſe the total ſtretching of a wire is ſo ſmall a quantity, that the miſtake of the 1000th part of an inch occaſions an irregularity which deranges any progreſſion ſo as to make it uſeleſs. But by the bending of bodies, a diſtenſion of $\frac{1}{100}$th of an inch may be eaſily magnified in the deflection of the ſpring ten thouſand times. We know that the inveſtigation is intricate and difficult, but not beyond the reach of our preſent mathematical attainments; and it will give very fine opportunities of employing all the addreſs of analyſis. In the 17th century and the beginning of the 18th this was a ſufficient excitement to the firſt geniuſes of Europe. The cycloid, the catenaria, the elaſtic curve, the velaria, the cauſtics, were reckoned an abundant recompenſe for much ſtudy; and James Bernoulli requeſted, as an honourable monument, that the logarithmic ſpiral might be inſcribed on his tombſtone. The reward for the ſtudy to which we now preſume to incite the mathematicians is the almoſt unlimited extenſion of natural ſcience, important in every particular branch. To go no further than our preſent ſubject, a great deal of important practical knowledge

ledge reſpecting the ſtrength of bodies is derived from the ſingle obſervation, that in the moderate extenſions which happen before the parts are overſtrained the forces are nearly in the proportion of the extenſions or ſeparations of the particles. To return to our ſubject.

70 Bernoulli calls in queſtion this law,

James Bernoulli, in his ſecond diſſertation on the elaſtic curve, calls in queſtion this law, and accommodates his inveſtigation to any hypotheſis concerning the relation of the forces and extenſions. He relates ſome experiments of lute ſtrings where the relation was conſiderably different. Strings of three feet long,

Stretched by	2, 4, 6, 8, 10 pds.
Were lengthened	9, 17, 23, 27, 30 lines.

But this is a moſt exceptionable form of the experiment. The ſtrings were twiſted, and the mechaniſm of the extenſions is here exceedingly complicated, combined with compreſſions and with tranſverſe twiſts, &c. We made experiments on fine ſlips of the gum caoutchouc, and on the juice of the berries of the white bryony, of which a ſingle grain will draw to a thread of two feet long, and again return into a perfectly round ſphere. We meaſured the diameter of the thread by a microſcope with a micrometer, and thus could tell in every ſtate of extenſion the proportional number of particles in the ſections. We found, that though the whole range in which the diſtance of the particles was changed in the proportion of 13 to 1, the extenſions did not *ſenſibly* deviate from the proportion of the forces. The ſame thing was obſerved in the caoutchouc as long as it perfectly recovered its firſt dimenſions. And it is on the authority of theſe experiments that we preſume to announce this as a law of nature.

71 which was firſt aſſumed by Dr Hooke.

Dr Robert Hooke was undoubtedly the firſt who attended to this ſubject, and aſſumed this as a law of nature. Mariotte indeed was the firſt who expreſsly uſed it for determining the ſtrength of beams: this he did about the 1679, correcting the ſimple theory of Galileo. Leibnitz indeed, in his diſſertation in the *Acta Eruditorum* 1684 *de Reſiſtentia Solidorum*, introduces this conſideration, and wiſhes to be conſidered as the diſcoverer; and he is always acknowledged as ſuch by the Bernoullis and others who adhered to his peculiar doctrines. But Marriottè had publiſhed the doctrine in the moſt expreſs terms long before; and Bulfinger, in the *Comment. Petropol.* 1729, completely vindicates his claim. But Hooke was unqueſtionably the diſcoverer of this law. It made the foundation of his theory of ſprings, announced to the Royal Society about the year 1661, and read in 1666. On this occaſion he mentions many things on the ſtrength of bodies as quite familiar to his thoughts, which are immediate deductions from this principle; and among theſe *all* the facts which John Bernoulli ſo vauntingly adduces in ſupport of Leibnitz's finical dogmas about the force of bodies in motion; a doctrine which Hooke might have claimed as his own, had he not perceived its frivolous inanity.

72 Though corrected by Mariotte, it does not properly explain the mechaniſm of tranſverſe ſtrain,

But even with this firſt correction of Marriottè, the mechaniſm of tranſverſe ſtrain is not fully nor juſtly explained. The force acting in the direction BP (fig. 5.), and bending the body ABCD, not only ſtretches the fibres on the ſide oppoſite to the axis of fracture, but compreſſes the ſide AB, which becomes concave by the ſtrain. Indeed it cannot do the one without doing the other: For in order to ſtretch the fibres at D, there muſt be ſome fulcrum, ſome ſupport, on which the virtual lever BAD may preſs, that it may tear aſunder the ſtretched fibres. This fulcrum muſt ſuſtain both the preſſure ariſing from the cohesion of the diſtended fibres, and alſo the action of the external force, which immediately tends to cauſe the prominent part of the beam to ſlide along the ſection DA. Let BAD (fig. 5.) be conſidered as a crooked lever, of which A is the fulcrum. Let an external force be applied at B in the direction BP, and let a force equal to the accumulated coheſion of AD be applied at O in the direction oppoſite to AB, that is, perpendicular to AO; and let theſe two forces be ſuppoſed to balance each other by the intervention of the lever. In the firſt place, the force at O muſt be to the force at B as AB to AO: Therefore, if we make AK equal and oppoſite to AO, and AL equal and oppoſite to AB, the common principles of mechanics inform us that the fulcrum A is affected in the ſame manner as if the two forces AK and AL were immediately applied to it, the force AK being equal to the weight P, and AL equal to the accumulated coheſion actually exerted in the inſtant of fracture. The fulcrum is therefore really preſſed in the direction AM, the diagonal of the parallelogram, and it muſt reſiſt in the direction and with the force MA; and this power of reſiſtance, this ſupport, muſt be furniſhed by the repulſive forces exerted by *thoſe particles only* which are in a ſtate of actual compreſſion. The force AK, which is equal to the external force P, muſt be reſiſted in the direction KA by the lateral coheſion of the whole particles between D and A (the particle D is not only drawn forward but downward). This prevents the part CDAB from ſliding down along the ſection DA.

73 as is fully verified by experiment.

This is fully verified by experiment. If we attempt to break a long ſlip of cork, or any ſuch very compreſſible body, we always obſerve it to bulge out on the concave ſide before it cracks on the other ſide. If it is a body of fibrous or foliated texture, it ſeldom fails ſplintering off on the concave ſide; and in many caſes this ſplintering is very deep, even reaching half way through the piece. In hard and granulated bodies, ſuch as a piece of freeſtone, chalk, dry clay, ſugar, and the like, we generally ſee a conſiderable ſplinter or ſhiver fly off from the hollow ſide. If the fracture be ſlowly made by a force at B gradually augmented, the formation of the ſplinter is very diſtinctly ſeen. It forms a triangular piece like *a* I *b*, which generally breaks in the middle. We doubt not but that attentive obſervation would ſhow that the direction of the crack on each ſide of I is not very different from the direction AM and its correſpondent on the other ſide. This is by no means a circumſtance of idle curioſity, but intimately connected with the mechaniſm of coheſion.

74 Conſequences reſulting from the ſtate of the caſe. Fig. 8.

Let us ſee what conſequences reſult from this ſtate of the caſe reſpecting the ſtrength of bodies. Let DΔKC (fig. 8.) repreſent a vertical ſection of a priſm of compreſſible materials, ſuch as a piece of timber. Suppoſe it loaded with a weight P hung at its extremity. Suppoſe it of ſuch a conſtitution that all the fibres in AD are in a ſtate of dilatation, while thoſe in AΔ are in a ſtate of compreſſion. In the inſtant of fracture the particles at D and E are with-held by forces D *d*, E *e*, and the particles at Δ and E repel, reſiſt, or ſupport, with forces Δ δ, E ε.

Some line, ſuch as *d c* A ε δ, will limit all theſe ordinates,

nates, which repreſent the forces actually exerted in the inſtant of fracture. If the forces be as the extenſions and compreſſions, as we have great reaſon to believe, deA and A$\epsilon\delta$ will be two ſtraight lines. They will form *one* ſtraight line dAδ, if the forces which reſiſt a certain dilatation are equal to the forces which reſiſt an equal compreſſion. But this is quite accidental, and is not ſtrictly true in any body. In moſt bodies which have any conſiderable firmneſs, the compreſſions made by any external force are not ſo great as the dilatations which the ſame force would produce; that is, the repulſions which are excited by any ſuppoſed degree of compreſſion are greater than the attractions excited by the ſame degree of dilatation. Hence it will generally follow, that the angle dAD is leſs than the angle δAΔ, and the ordinates Dd, Ee, &c. are leſs than the correſponding ordinates $\Delta\delta$, Eϵ, &c.

But whatever be the nature of the line dAδ, we are certain of this, that the whole area ADd is equal to the whole area A$\Delta\delta$: for as the force at B is gradually increaſed, and the parts between A and D are more extended, and greater coheſive forces are excited, there is always ſuch a degree of repulſive forces excited in the particles between A and Δ that the one ſet preciſely balances the other. The force at B, acting perpendicularly to AB, has no tendency to puſh the whole piece cloſer on the part next the wall or to pull it away. The ſum of the attractive and repulſive forces actually excited muſt therefore be equal. Theſe ſums are repreſented by the two triangular areas, which are therefore equal.

The greater we ſuppoſe the repulſive forces correſponding to any degree of compreſſion, in compariſon with the attractive forces correſponding to the ſame degree of extenſion, the ſmaller will AΔ be in compariſon of AD. In a piece of cork or ſponge, AΔ may chance to be equal to AD, or even to exceed it; but in a piece of marble, AΔ will perhaps be very ſmall in compariſon of AD.

75
An important conſequence of the compreſſibility of body fully proved.

Now it is evident that the repulſive forces excited between A and Δ have no ſhare in preventing the fracture. They rather contribute to it, by furniſhing a fulcrum to the lever, by whoſe energy the coheſion of the particles in AD is overcome. Hence we ſee an important conſequence of the compreſſibility of the body. Its power of reſiſting this tranſverſe ſtrain is diminiſhed by it, and ſo much the more diminiſhed as the ſtuff is more compreſſible.

This is fully verified by ſome very curious experiments made by Du Hamel. He took 16 bars of willow 2 feet long and $\frac{1}{2}$ an inch ſquare, and ſupporting them by props under the ends, he broke them by weights hung on the middle. He broke 4 of them by weights of 40, 41, 47, and 52 pounds: the mean is 45. He then cut 4 of them $\frac{1}{3}$d through on the upper ſide, and filled up the cut with a thin piece of harder wood ſtuck in pretty tight. Theſe were broken by 48, 54, 50, and 52 pounds; the mean of which is 51. He cut other four $\frac{1}{2}$ through, and they were broken by 47, 49, 50, 46; the mean of which is 48. The remaining four were cut $\frac{2}{3}$ds; and their mean ſtrength was 42.

Another ſet of his experiments is ſtill more remarkable.

Six battens of willow 36 inches long and $1\frac{2}{2}$ ſquare were broken by 525 pounds at a medium.

Six bars were cut $\frac{1}{3}$d through, and the cut filled with a wedge of hard wood ſtuck in with a little force: theſe broke with 551.

Six bars were cut half through, and the cut was filled in the ſame manner: they broke with 542.

Six bars were cut $\frac{3}{4}$ths through: theſe broke with 530.

A batten cut $\frac{3}{4}$ths through, and loaded till nearly broken, was unloaded, and the wedge taken out of the cut. A thicker wedge was put in tight, ſo as to make the batten ſtraight again by filling up the ſpace left by the compreſſion of the wood: this batten broke with 577 pounds.

From this it is plain that more than $\frac{2}{3}$ds of the thickneſs (perhaps nearly $\frac{3}{4}$ths) contributed nothing to the ſtrength.

The point A is the centre of fracture in this caſe; and in order to eſtimate the ſtrength of the piece, we may ſuppoſe that the crooked lever virtually concerned in the ſtrain is DAB. We muſt find the point I, which is the centre of effort of all the attractive forces, or that point where the full coheſion of AD muſt be applied, ſo as to have a momentum equal to the accumulated momenta of all the variable forces. We muſt in like manner find the centre of effort i of the repulſive or ſupporting forces exerted by the fibres lying between A and Δ.

It is plain, and the remark is important, that this laſt centre of effort is the real fulcrum of the lever, although A is the point where there is neither extenſion nor contraction; for the lever is ſupported in the ſame manner as if the repulſions of the whole line AΔ were exerted at that point. Therefore let S repreſent the ſurface of fracture from A to D, and f repreſent the abſolute coheſion of a fibre at D in the inſtant of fracture. We ſhall have $fS \times \overline{I+i} = pl$, or $l : I+i = fS : p$; that is, the length AB is to the diſtance between the two centres of effort I and i, as the abſolute coheſion of the ſection between A and D is to the relative ſtrength of the ſection.

It would be perhaps more accurate to make AI and Ai equal to the diſtances of A from the horizontal lines paſſing through the centres of gravity of the triangles dAD and δAΔ. It is only in this conſtruction that the points I and i are the centres of real effort of the accumulated attractions and repulſions. But I and i, determined as we have done, are the points where the full, equal, actions may be all applied, ſo as to produce the ſame momenta. The final reſults are the ſame in both caſes. The attentive and duly informed reader will ſee that Mr Bulfinger, in a very elaborate diſſertation on the ſtrength of beams in the *Comment. Petropolitan.* 1729, has committed ſeveral miſtakes in his eſtimation of the actions of the fibres. We mention this becauſe his reaſonings are quoted and appealed to as authorities by Muſchenbroek and other authors of note. The ſubject has been conſidered by many authors on the continent. We recommend to the reader's peruſal the very minute diſcuſſions in the Memoirs of the Academy of Paris for 1702 by Varignon, the Memoirs for 1708 by Parent, and particularly that of Coulomb in the *Mem. par les Sçavans Etrangers*, tom. vii.

It is evident from what has been ſaid above, that if S and s repreſent the ſurfaces of the ſections above and below A, and if G and g are the diſtances of their centres of gravity from A, and O and o the diſtances of their

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centres of oscillation, and D and d their whole depths, the momentum of cohesion will be $\frac{f S \cdot G \cdot O}{D} = \frac{f s . g . o}{d} = p l$.

If (as is most likely) the forces are proportional to the extensions and compressions, the distances AI and Ai, which are respectively $= \frac{G \cdot O}{D}$ and $\frac{g . o}{d}$, are respectively $= \frac{2}{3}$ DA, and $\frac{2}{3}\, \Delta$ A ; and when taken together are $= \frac{2}{3}$ D Δ. If, moreover, the extensions are equal to the compressions in the instant of fracture, and the body is a rectangular prism like a common joist or beam, then D A and Δ A are also equal; and therefore the momentum of cohesion is $f b \times \frac{1}{2} d \times \frac{1}{3} d, = \frac{f b d^2}{6}, = f b d \times \frac{1}{6} d = p l$. Hence we obtain this analogy, "Six times the length is to the depth as the absolute cohesion of the section is to its relative strength."

76
This consequence farther explained.

Thus we see that the compressibility of bodies has a very great influence on their power of withstanding a transverse strain. We see that in this most favourable supposition of equal dilatations and compressions, the strength is reduced to one half of the value of what it would have been had the body been incompressible. This is by no means obvious; for it does not readily appear how compressibility, which does not diminish the cohesion of a single fibre, should impair the strength of the whole. The reason, however, is sufficiently convincing when pointed out. In the instant of fracture a smaller portion of the section is actually exerting cohesive forces, while a part of it is only serving as a fulcrum to the lever, by whose means the strain on the section is produced. We see too that this diminution of strength does not so much depend on the sensible compressibility, as on its proportion to the dilatability by equal forces. When this proportion is small, A Δ is small in comparison of AD, and a greater portion of the whole fibre is exerting attractive forces. The experiments already mentioned, of Du Hamel de Monceau, on battens of willow, show that its compressibility is nearly equal to its dilatability. But the case is not very different in tempered steel. The famous Harrison, in the delicate experiments which he made while occupied in making his longitude watch, discovered that a rod of tempered steel was nearly as much diminished in its length as it was augmented by the same external force. But it is not by any means certain that this is the proportion of dilatation and compression which obtains in the very instant of fracture. We rather imagine that it is not. The forces are nearly as the dilatations till very near breaking; but we think that they diminish when the body is just going to break. But it seems certain that the forces which resist compression increase faster than the compressions, even before fracture. We know incontestably that the ultimate resistances to compression are insuperable by any force which we can employ. The repulsive forces therefore (in their whole extent) increase faster than the compressions, and are expressed by an assymptotic branch of the Boscovician curve formerly explained. It is therefore probable, especially in the more simple substances, that they increase faster, even in such compressions as frequently obtain in the breaking of hard bodies. We are disposed to think that this is always the case in such bodies as do not fly off in splinters on the concave side; but this must be understood with the exception of the permanent changes which may be made by compression, when the bodies are crippled by it. This always increases the compression itself, and causes the neutral point to shift still more towards D. The effect of this is sometimes very great and fatal.

Experiment alone can help us to discover the proportion between the dilatability and compressibility of bodies. The strain now under consideration seems the best calculated for this research. Thus if we find that a piece of wood an inch square requires 12,000 pounds to tear it asunder by a direct pull, and that 200 pounds will break it transversely by acting 10 inches from the section of fracture, we must conclude that the neutral point A is in the middle of the depth, and that the attractive and repulsive forces are equal. Any notions that we can form of the constitution of such fibrous bodies as timber, make us imagine that the *sensible* compressions, including what arises from the bending up of the compressed fibres, is much greater than the real corpuscular extensions. One may get a general conviction of this unexpected proposition by reflecting on what must happen during the fracture. An undulated fibre can only be drawn straight, and then the corpuscular extension begins; but it may be bent up by compression to any degree, the corpuscular compression being little affected all the while. This observation is very important; and though the forces of corpuscular repulsion may be almost insuperable by any compression that we can employ, a *sensible* compression may be produced by forces not enormous, sufficient to cripple the beam. Of this we shall see very important instances afterwards.

77
The proportional strengths of different pieces follow the same ratio.

It deserves to be noticed, that although the relative strength of a prismatic solid is extremely different in the three hypotheses now considered, yet the proportional strengths of different pieces follow the same ratio; namely, the direct ratio of the breadth, the direct ratio of the square of the depth, and the inverse ratio of the length. In the first hypothesis (of equal forces) the strength of a rectangular beam was $\frac{f b d^2}{2 l}$; in the second (of attractive forces proportioned to the extensions) it was $\frac{f b d^2}{3 l}$; and in the third (equal attractions and repulsions proportional to the extensions and compressions) it was $\frac{f b d^2}{6 l}$, or more generally $\frac{f b d^2}{m l}$, where m expresses the unknown proportion between the attractions and repulsions corresponding to an equal extension and compression.

78
The strength of a piece depends chiefly on its depth.

Hence we derive a piece of useful information, which is confirmed by unexceptionable experience, that the strength of a piece depends chiefly on its depth, that is, on that dimension which is in the direction of the strain. A bar of timber of one inch in breadth and two inches in depth is four times as strong as a bar of only one inch deep, and it is twice as strong as a bar two inches broad and one deep; that is, a joist or lever is always strongest when laid on its edge.

79
And therefore a choice in the manner in which the cohesion is opposed to the strain.

There is therefore a choice in the manner in which the cohesion is opposed to the strain. The general aim must be to put the centre of effort I as far from the fulcrum or the neutral point A as possible, so as to give the greatest energy or momentum to the cohesion. Thus if a triangular bar projecting from a wall is loaded with a weight

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weight at its extremity, it will bear thrice as much when one of the ſides is uppermoſt as when it is undermoſt. The bar of fig. 6. would be three times as ſtrong if the ſide AB were uppermoſt and the edge DC undermoſt.

80 The ſtrongeſt joiſt has not the greateſt quantity of timber. Fig. 9.

Hence it follows that the ſtrongeſt joiſt that can be cut out of a round tree is not the one which has the greateſt quantity of timber in it, but ſuch that the product of its breadth by the ſquare of its depth ſhall be the greateſt poſſible. Let ABCD (fig. 9.) be the ſection of this joiſt inſcribed in the circle, AB being the breadth and AD the depth. Since it is a rectangular ſection, the diagonal BD is a diameter of the circle, and BAD is a right-angled triangle. Let BD be called a, and BA be called x; then AD is $=\sqrt{a^2-x^2}$. Now we muſt have $AB \times AD^2$, or $x \times a^2 - x^2$, or $a^2 x - x^3$, a maximum. Its fluxion $a^2\dot{x} - 3x^2\dot{x}$ muſt be made $=0$, or $a^2 = 3x^2$, or $x^2 = \frac{a^2}{3}$. If therefore we make $DE = \frac{1}{3}$ DB, and draw EC perpendicular to BD, it will cut the circumference in the point C, which determines the depth BC and the breadth CD.

Becauſe $BD : BC = CD : CE$, we have the area of the ſection $BC\cdot CD = BD\cdot CE$. Therefore the different ſections having the ſame diagonal BD are proportional to their heights CE. Therefore the ſection BCDA is leſs than the ſection $BcDa$, whoſe four ſides are equal. The joiſt ſo ſhaped, therefore, is both ſtronger, lighter, and cheaper.

81 A hollow tube ſtronger than a ſolid rod containing the ſame quantity of matter, Fig. 10.

The ſtrength of ABCD is to that of a B c D as 10,000 to 9186, and the weight and expence as 10,000 to 10,607; ſo that ABCD is preferable to a B c D in the proportion of 10,607 to 9186, or nearly 115 to 100.

From the ſame principles it follows that a hollow tube is ſtronger than a ſolid rod containing the ſame quantity of matter. Let fig. 10. repreſent the ſection of a cylindric tube, of which AF and BE are the exterior and interior diameters, and C the centre. Draw BD perpendicular to BC, and join DC. Then, becauſe $BD^2 = CD^2 - CB^2$, BD is the radius of a circle containing the ſame quantity of matter with the ring. If we eſtimate the ſtrength by the firſt hypotheſis, it is evident that the ſtrength of the tube will be to that of the ſolid cylinder, whoſe radius is BD, as $BD^2 \times AC$ to $BD^2 \times BD$; that is, as AC to BD: for BD^2 expreſſes the coheſion of the ring or the circle, and AC and BD are equal to the diſtances of the centres of effort (the ſame with the centres of gravity) of the ring and circle from the axis of the fracture.

The proportion of theſe ſtrengths will be different in the other hypotheſes, and is not eaſily expreſſed by a general formula; but in both it is ſtill more in favour of the ring or hollow tube.

The following very ſimple ſolution will be readily underſtood by the intelligent reader. Let O be the centre of oſcillation of the exterior circle, o the centre of oſcillation of the inner circle, and w the centre of oſcillation of the ring included between them. Let M be the quantity of ſurface of the exterior circle, m that of the inner circle, and μ that of the ring.

We have $Fw = \frac{M\cdot FO - m.Fo}{\mu}, = \frac{5FC^2 + EC^2}{4FC}$

and the ſtrength of the ring $= \frac{f\mu \times Fw}{2}$, and the ſtrength of the ſame quantity of matter in the form of a ſolid cylinder is $f\mu \times \frac{5}{8}$ BD; ſo that the ſtrength of the ring is to that of the ſolid rod of equal weight as Fw to $\frac{5}{4}$ BD, or nearly as FC to BD. This will eaſily appear by recollecting that FO is $= \frac{\text{ſum of } p.\,r^2}{m.\,FC}$ (ſee ROTATION), and that the momentum of coheſion is $\frac{fm\cdot FC\cdot Ca}{2FC} = \frac{fm\cdot Fo}{2}$ for the inner circle, &c.

Emerſon has given a very inaccurate approximation to this value in his *Mechanics*, 4to.

82 and more ſtiff.

This property of hollow tubes is accompanied alſo with greater ſtiffneſs; and the ſuperiority in ſtrength and ſtiffneſs is ſo much the greater as the ſurrounding ſhell is thinner in proportion to its diameter.

83 Hence the wiſdom of God in forming the bones, &c. hollow.

Here we ſee the admirable wiſdom of the Author of nature in forming the bones of animal limbs hollow. The bones of the arms and legs have to perform the office of levers, and are thus oppoſed to very great tranſverſe ſtrains. By this form they become incomparably ſtronger and ſtiffer, and give more room for the inſertion of muſcles, while they are lighter and therefore more agile; and the ſame Wiſdom has made uſe of this hollow for other valuable purpoſes of the animal economy. In like manner the quills in the wings of birds acquire by their thinneſs the very great ſtrength which is neceſſary, while they are ſo light as to give ſufficient buoyancy to the animal in the rare medium in which it muſt live and fly about. The ſtalks of many plants, ſuch as all the graſſes, and many reeds, are in like manner hollow, and thus poſſeſs an extraordinary ſtrength. Our beſt engineers now begin to imitate nature by making many parts of their machines hollow, ſuch as their axles of caſt iron, &c.; and the ingenious Mr Ramſden now makes the axes and framings of his great aſtronomical inſtruments in the ſame manner.

In the ſuppoſition of homogeneous texture, it is plain that the fracture happens as ſoon as the particles at D are ſeparated beyond their utmoſt limit of coheſion. This is a determined quantity, and the piece bends till this degree of extenſion is produced in the outermoſt fibre. It follows, that the ſmaller we ſuppoſe the diſtance between A and D, the greater will be the curvature which the beam will acquire before it breaks. Greater depth therefore makes a beam not only ſtronger but alſo ſtiffer. But if the parallel fibres can ſlide on each other, both the ſtrength and the ſtiffneſs will be diminiſhed. Therefore if, inſtead of one beam D Δ KC

Fig. 8. 84 How a ſtrong compound beam may be formed.

(fig. 8.) we ſuppoſe two, D Δ BC and AΔKB, not cohering, each of them will bend, and the extenſion of the fibres AB of the under beam will not hinder the compreſſion of the adjoining fibres AB of the upper beam. The two together therefore will not be more than twice as ſtrong as one of them (ſuppoſing DA = A Δ) inſtead of being four times as ſtrong; and they will bend as much as either of them alone would bend by half the load. This may be prevented, if it were poſſible to unite the two beams all along the ſeam AB, ſo that the one ſhall not ſlide on the other. This may be done in ſmall works, by gluing them together with a cement as ſtrong as the natural lateral coheſion of the fibres. If this cannot be done (as it cannot in large works), the ſliding is prevented by JOGGLING the beams together; that is, by cutting down ſeveral rectangular notches in the upper ſide of the lower beam, and making ſimilar notches

in

Strength of Materials.

in the under ſide of the upper beam, and filling up the ſquare ſpaces with pieces of very hard wood firmly driven in, as repreſented in fig. 11. Some employ iron bolts by way of joggles. But when the joggle is much harder than the wood into which it is driven, it is very apt to work looſe, by widening the hole into which it is lodged. The ſame thing is ſometimes done by ſcarfing the one upon the other, as repreſented in fig. 12.); but this waſtes more timber, and is not ſo ſtrong, becauſe the mutual hooks which this method forms on each beam are very apt to tear each other up. By one or other of theſe methods, or ſomething ſimilar, may a compound beam be formed, of any depth, which will be almoſt as ſtiff and ſtrong as an entire piece.

85
How ſtrength may be combined with pliableneſs.

On the other hand, we may combine ſtrength with pliableneſs, by compoſing our beam of ſeveral thin planks laid on each other, till they make a proper depth, and leaving them at full liberty to ſlide on each other. It is in this manner that coach-ſprings are formed, as is repreſented in fig. 13. In this aſſemblage there muſt be no joggles nor bolts of any kind put through the planks or plates; for this would hinder their mutual ſliding. They muſt be kept together by ſtraps which ſurround them, or by ſomething equivalent.

86
Maxims of conſtruction.

The preceding obſervations ſhow the propriety of ſome maxims of conſtruction, which the artiſts have derived from long experience.

Thus, if a mortiſe is to be cut out of a piece which is expoſed to a croſs ſtrain, it ſhould be cut out from that ſide which becomes concave by the ſtrain, as in fig. 14. but by no means as in fig. 15.

If a piece is to be ſtrengthened by the addition of another, the added piece muſt be joined to the ſide which grows convex by the ſtrain, as in fig. 16. and 17.

Before we go any farther, it will be convenient to recal the reader's attention to the analogy between the ſtrain on a beam projecting from a wall and loaded at the extremity, and a beam ſupported at both ends and loaded in ſome intermediate point. It is ſufficient on this occaſion to read attentively what is delivered in the article ROOF, N° 19.—We learn there that the ſtrain on the middle point C (fig. 17. of the preſent article) of a rectangular beam AB, ſupported on props at A and B, is the ſame as if the part CA projected from a wall, and were loaded with the half of the weight W ſuſpended at A. The momentum of the ſtrain is therefore $\frac{1}{2}W \times \frac{1}{2}AB, = W \times \frac{1}{4}AB = p\,\frac{1}{4}\,l$, or $\frac{p\,l}{4}$. The momentum of coheſion muſt be equal to this in every hypotheſis.

Having now conſidered in ſufficient detal the circumſtances which affect the ſtrength of any ſection of a ſolid body that is ſtrained tranſverſely, it is neceſſary to take notice of ſome of the chief modifications of the ſtrain itſelf. We ſhall conſider only thoſe that occur moſt frequently in our conſtructions.

The ſtrain depends on the external force, and alſo on the lever by which it acts.

87
The ſtrain depends on the external force.

It is evidently of importance, that ſince the ſtrain is exerted in any ſection by means of the coheſion of the parts intervening between the ſection under conſideration and the point of application of the external force, the body muſt be able in all theſe intervening parts to propagate or excite the ſtrain in the remote ſection. In every part it muſt be able to reſiſt the ſtrain excited in that part. It ſhould therefore be equally ſtrong; and it is uſeleſs to have any part ſtronger, becauſe the piece will nevertheleſs break where it is not ſtronger throughout; and it is uſeleſs to make it ſtronger (relatively to its ſtrain) in any part, for it will nevertheleſs equally fail in the part that is too weak.

Suppoſe then, in the firſt place, that the ſtrain ariſes from a weight ſuſpended at one extremity, while the other end is firmly fixed in a wall. Suppoſing alſo the croſs ſections to be all rectangular, there are ſeveral ways of ſhaping the beam ſo that it ſhall be equally ſtrong throughout. Thus it may be equally deep in every part, the upper and under ſurfaces being horizontal planes. The condition will be fulfilled by making all the horizontal ſections triangles, as in fig. 18. The two ſides are vertical planes meeting in an edge at the extremity L. For the equation expreſſing the balance of ſtrain and ſtrength is $p\,l = f\,b\,d^2$. Therefore ſince d^2 is the ſame throughout, and alſo p, we muſt have $fb = l$, and b (the breadth AD of any ſection ABCD) muſt be proportional to l (or AL), which it evidently is.

Or, if the beam be of uniform breadth, we muſt have d^2 everywhere proportional to l. This will be obtained by making the depths the ordinates of a common parabola, of which L is the vertex and the length is the axis. The upper or under ſide may be a ſtraight line, as in fig. 19. or the middle line may be ſtraight, and then both upper and under ſurfaces will be curved. It is almoſt indifferent what is the ſhape of the upper and under ſurfaces, provided the diſtances between them in every part be as the ordinates of a common parabola.

Or, if the ſections are all ſimilar, ſuch as circles, ſquares, or any other ſimilar polygons, we muſt have d^3 or b^3 proportional to l, and the depths or breadths muſt be as the ordinates of a cubical parabola.

88
And on the form of the levers by which it acts.

It is evident that theſe are alſo the proper forms for a lever moveable round a fulcrum, and acted on by a force at the extremity. The force comes in the place of the weight ſuſpended in the caſes already conſidered; and as ſuch levers always are connected with another arm, we readily ſee that both arms ſhould be faſhioned in the ſame manner. Thus in fig. 18. the piece of timber may be ſuppoſed a kind of ſteelyard, moveable round a horizontal axis OP, in the front of the wall, and having the two weights P and π in equilibrio. The ſtrain occaſioned by each at the ſection in which the axis OP is placed muſt be the ſame, and each arm OL and Oλ muſt be equally ſtrong in all its parts. The longitudinal ſections of each arm muſt be a triangle, a common parabola, or a cubic parabola, according to the conditions previouſly given.

And, moreover, all theſe forms are equally ſtrong: For any one of them is equally ſtrong in all its parts, and they are all ſuppoſed to have the ſame ſection at the front of the wall or at the fulcrum. They are not, however, equally ſtiff. The firſt, repreſented in fig. 18. will bend leaſt upon the whole, and the one formed by the cubic parabola will bend moſt. But their curvature at the very fulcrum will be the ſame in all.

It is alſo plain, that if the lever is of the ſecond or third kind, that is, having the fulcrum at one extremity, it muſt ſtill be of the ſame ſhape; for in abſtract mechanics it is indifferent which of the three points is conſidered as the axis of motion. In every lever the two

two forces at the extremities act in one direction, and the force in the middle acts in the oppoſite direction, and the great ſtrain is always at that point. Therefore a lever ſuch as fig. 18. moveable round an axis paſſing horizontally through λ, and acting againſt an obſtacle at OP, is equally able in all its parts to reſiſt the ſtrains excited in thoſe parts.

The ſame principles and the ſame conſtruction will apply to beams, ſuch as joiſts, ſupported at the ends L and λ (fig. 18.), and loaded at ſome intermediate part OP. This will appear evident by merely inverting the directions of the forces at theſe three points, or by recurring to the article Roofs, N° 19.

89
The external ſtraining force may be diſtributed over the beam.

Hitherto we have ſuppoſed the external ſtraining force as acting only in one point of the beam. But it may be uniformly diſtributed all over the beam. To make a beam in ſuch circumſtances equally ſtrong in all its parts, the ſhape muſt be conſiderably different from the former.

90
To make a beam ſtrong which projects from a wall.

Thus ſuppoſe the beam to project from a wall.

If it be of equal breadth throughout, its ſides being vertical planes parallel to each other and to the length, the vertical ſection in the direction of its length muſt be a triangle inſtead of a common parabola; for the weight uniformly diſtributed over the part lying beyond any ſection, is as the length beyond that ſection: and ſince it may all be conceived as collected at its centre of gravity, which is the middle of that length, the lever by which this load acts or ſtrains the ſection is alſo proportional to the ſame length. The ſtrain on the ſection (or momentum of the load) is as the ſquare of that length. The ſection muſt have ſtrength in the ſame proportion. Its ſtrength being as the breadth and the ſquare of the depth, and the breadth being conſtant, the ſquare of the depth of any ſection muſt be as the ſquare of its diſtance from the end, and the depth muſt be as that diſtance; and therefore the longitudinal vertical ſection muſt be a triangle.

But if all the tranſverſe ſections are circles, ſquares, or any other ſimilar figures, the ſtrength of every ſection, or the cube of the diameter, muſt be as the ſquare of the lengths beyond that ſection, or the ſquare of its diſtance from the end; and the ſides of the beam muſt be a ſemicubical parabola.

If the upper and under ſurfaces are horizontal planes, it is evident that the breadth muſt be as the ſquare of the diſtance from the end, and the horizontal ſections may be formed by arches of the common parabola, having the length for their tangent at the vertex.

By recurring to the analogy ſo often quoted between a projecting beam and a joiſt, we may determine the proper form of joiſts which are uniformly loaded through their whole length.

91
The ſtrain upon a beam ſupported at both ends. Fig. 20.

This is a frequent and important caſe, being the office of joiſts, rafters, &c.; and there are ſome circumſtances which muſt be particularly noticed, becauſe they are not ſo obvious, and have been miſunderſtood. When a beam AB (fig. 20.) is ſupported at the ends, and a weight is laid on any point P, a ſtrain is excited in every part of the beam. The load on P cauſes the beam to preſs on A and B, and the props react with forces equal and oppoſite to theſe preſſures. The load at P is to the preſſures at A and B as AB to PB and PA, and the preſſure at A is to that at B as PB to PA; the beam therefore is in the ſame ſtate, with reſpect to ſtrain in every part of it, as if it were reſting on a prop at P, and were loaded at the ends with weights equal to the two preſſures on the props: and obſerve, theſe preſſures are ſuch as will balance each other, being inverſely as their diſtances from P. Let P repreſent the weight or load at P. The preſſure on the prop P muſt be $P \times \frac{PA}{AB}$. This is therefore the reaction of the prop B, and is the weight which we may ſuppoſe ſuſpended at B, when we conceive the beam reſting on a prop at P, and carrying the balancing weights at A and B.

The ſtrain occaſioned at any other point C, by the load P at P, is the ſame with the ſtrain at C, by the weight $P \times \frac{PA}{AB}$ hanging at B, when the beam reſts on P, in the manner now ſuppoſed; and it is the ſame if the beam, inſtead of being balanced on a prop at P, had its part AP fixed in a wall. This is evident. Now we have ſhown at length that the ſtrain at C, by the weight $P \times \frac{PA}{AB}$ hanging at B, is $P \times \frac{PA}{AB} \times BC$. We deſire it to be particularly remarked that the preſſure at A has no influence on the ſtrain at C, ariſing from the action of any load between A and C; for it is indifferent how the part AP of the projecting beam PB is ſupported. The weight at A juſt performs the ſame office with the wall in which we ſuppoſe the beam to be fixed. We are thus particular, becauſe we have ſeen even perſons not unaccuſtomed to diſcuſſions of this kind puzzled in their conceptions of this ſtrain.

Now let the load P be laid on ſome point p between C and B. The ſame reaſoning ſhows us that the point is (with reſpect to ſtrain) in the ſame ſtate as if the beam were fixed in a wall, embracing the part pB, and a weight $= P \times \frac{pB}{AB}$ were hung on at A, and the ſtrain at C is $P \times \frac{pB}{AB} \times AC$.

92
A general propoſition.

In general, therefore, the ſtrain on any point C, ariſing from a load P laid on another point P, is proportional to the rectangle of the diſtances of P and C from the ends neareſt to each. It is $P \times \frac{PA \times CB}{AB}$, or $P \times \frac{pB \times CA}{AB}$, according as the load lies between C and A or between C and B.

Cor. 1. The ſtrains which a load on any point P occaſions on the points C, c, lying on the ſame ſide of P, are as the diſtances of theſe points from the end B. In like manner the ſtrains on E and e are as EA and eA.

Cor. 2. The ſtrain which a load occaſions in the part on which it reſts is as the rectangle of the parts on each ſide. Thus the ſtrain occaſioned at C by a load is to that at D by the ſame load as $AC \times CB$ to $AD \times DB$. It is therefore greateſt in the middle.

93
The ſtrain ariſing from a load diſtributed along the beam.

Let us now conſider the ſtrain on any point C ariſing from a load uniformly diſtributed along the beam. Let AP be repreſented by x, and Pp by $\dot{x}$, and the whole weight on the beam by a. Then

The weight on Pp is . $= a \frac{\dot{x}}{AB}$,

Preſſure

Preſſure on B by the weight on Pp $= a\frac{\dot{x}}{AB} \times \frac{}{AB}$

Or - - - $= a\frac{x\dot{x}}{AB^2}$.

Preſ. on B by whole wt. on AC $= a\frac{\frac{1}{2}AC^2}{AB^2} = a\frac{AC^2}{2AB^2}$.

Strain at C by the weight on AC $= a\frac{AC^2 \times BC}{2\,AB^2}$.

Strain at C by the weight on BC $= a\frac{BC^2 \times AC}{2\,AB^2}$.

Do. by whole weight on AB $= a\frac{AC^2 \times BC + BC^2 \times AC}{2\,AB^2}$,

$= a\frac{AC \times BC \times \overline{AC + CB}}{2\,AB^2}, = a\frac{AC \times BC}{2\,AB}$.

Thus we ſee that the ſtrain is proportional to the rectangle of the parts, in the ſame manner as if the load a had been laid directly on the point C, and is indeed equal to one-half of the ſtrain which would be produced at C by the load a laid on there.

94 Miſtakes in this ſubject committed by authors of reputation.

It was neceſſary to be thus particular, becauſe we ſee in ſome elementary treatiſes of mechanics, publiſhed by authors of reputation, miſtakes which are very plauſible, and miſlead the learner. It is there ſaid, that the preſſure at B from a weight uniformly diffuſed along AB is the ſame as if it were collected at its centre of gravity, which would be the middle of AB; and then the ſtrain at C is ſaid to be this preſſure at B multiplied by BC. But ſurely it is not difficult to ſee the difference of theſe ſtrains. It is plain that the preſſure of gravity downwards on any point between the end A and the point C has no tendency to diminiſh the ſtrain at C, ariſing from the upward reaction of the prop B; whereas the preſſure of gravity between C and B is almoſt in direct oppoſition to it, and muſt diminiſh it. We may however avoid the fluxionary calculus with ſafety by the conſideration of the centre of gravity, by ſuppoſing the weights of AC and BC to be collected at their reſpective centres of gravity; and the reſult of this computation will be the ſame as above: and we may uſe either method, although the weight is not uniformly diſtributed, provided only that we know in what manner it is diſtributed.

This inveſtigation is evidently of importance in the practice of the engineer and architect, informing them what ſupport is neceſſary in the different parts of their conſtructions. We conſidered ſome caſes of this kind in the article ROOFS.

95 To form a joiſt which may have the ſame relative ſtrength in all its parts.

It is now eaſy to form a joiſt, ſo that it ſhall have the ſame relative ſtrength in all its parts.

I. To make it equally able in all its parts to carry a given weight laid on any point C taken at random, or uniformly diffuſed over the whole length, the ſtrength of the ſection at the point C muſt be as AC $\times$ CB. Therefore

1. If the ſides are parallel vertical planes, the ſquare of the depth (which is the only variable dimenſion) or CD^2, muſt be as $AC \times CB$, and the depths muſt be ordinates of an ellipſe.

2. If the tranſverſe ſections are ſimilar, we muſt make CD^3 as $AC \times CB$.

3. If the upper and under ſurfaces are parallel, the breadth muſt be as $AC \times CB$.

II. If the beam is neceſſarily loaded at ſome given point C, and we would have the beam equally able in all its parts to reſiſt the ſtrain ariſing from the weight at C, we muſt make the ſtrength of every tranſverſe ſection between C and either end as its diſtance from that end. Therefore

1. If the ſides are parallel vertical planes, we muſt make $CD^2 : EF^2 = AC : AE$.

2. If the ſections are ſimilar, then $CD^3 : EF^3 = AC : AE$.

3. If the upper and under ſurfaces are parallel, then, breadth at C : breadth at E $= AC : AE$.

96 The ſtrain and ſtrength of ſquare or circular plates of different extent, but of equal thickneſs, may be determined from the ſame principles.

The ſame principles enable us to determine the ſtrain and ſtrength of ſquare or circular plates, of different extent, but equal thickneſs. This may be comprehended in this general propoſition.

Similar plates of equal thickneſs ſupported all round will carry the ſame abſolute weight, uniformly diſtributed, or reſting on ſimilar points, whatever is their extent.

Suppoſe two ſimilar oblong plates of equal thickneſs, and let their lengths and breadths be L, l, and B, b. Let their ſtrength or momentum of coheſion be C, c, and the ſtrains from the weights W, w, be S, s.

Suppoſe the plates ſupported at the ends only, and reſiſting fracture tranſverſely. The ſtrains, being as the weights and lengths, are as WL and $w\,l$, but their coheſions are as the breadths; and ſince they are of equal relative ſtrength, we have $WL : w\,l = B : b$, and $WLb = w\,l\,B$ and $L : l = w\,B : W\,b$: but ſince they are of ſimilar ſhapes $L : l = B : b$, and therefore $w = W$.

The ſame reaſoning holds again when they are alſo ſupported along the ſides, and therefore holds when they are ſupported all round (in which caſe the ſtrength is doubled).

And if the plates are of any other figure, ſuch as circles or ellipſes, we need only conceive ſimilar rectangles inſcribed in them. Theſe are ſupported all around by the continuity of the plates, and therefore will ſuſtain equal weights; and the ſame may be ſaid of the ſegments which lie without them, becauſe the ſtrengths of any ſimilar ſegments are equal, their lengths being as their breadths.

Therefore the thickneſs of the bottoms of veſſels holding heavy liquors or grains ſhould be as their diameters, and as the ſquare root of their depths jointly.

Alſo the weight which a ſquare plate will bear is to that which a bar of the ſame matter and thickneſs will bear as twice the length of the bar to its breadth.

97 The ſtrain of a beam ariſing from its own weight.

There is yet another modification of the ſtrain which tends to break a body tranſverſely, which is of very frequent occurrence, and in ſome caſes muſt be very carefully attended to, viz. the ſtrain ariſing from its own weight.

When a beam projects from a wall, every ſection is ſtrained by the weight of all that projects beyond it. This may be conſidered as all collected at its centre of gravity. Therefore the ſtrain on any ſection is in the joint ratio of the weight of what projects beyond it, and the diſtance of its centre of gravity from the ſection.

The determination of this ſtrain and of the ſtrength neceſſary for withſtanding it muſt be more complicated than the former, becauſe the form of the piece which reſults from this adjuſtment of ſtrain and ſtrength influence.

ences the ſtrain. The general principle muſt evidently be, that the ſtrength or momentum of coheſion of every ſection muſt be as the product of the weight beyond it multiplied by the diſtance of its centre of gravity. For example:

98 General principle reſpecting it. Fig. 21.

Suppoſe the beam DLA (fig. 21.) to project from the wall, and that its ſides are parallel vertical planes, ſo that the depth is the only variable dimenſion. Let $LB = x$ and $Bb = y$. The element $Bbc\,C$ is $= y\dot{x}$. Let G be the centre of gravity of the part lying without Bb, and g be its diſtance from the extremity L. Then $x-g$ is the arm of the lever by which the ſtrain is excited in the ſection Bb. Let Bb or y be as ſome power m of LB; that is, let $y = x^m$. Then the contents of LBb is $\frac{x^{m+1}}{m+1}$. The momentum of gravity round a horizontal axis at L is $yx\dot{x} = x^{m+1}\dot{x}$, and the whole momentum round the axis is $\frac{x^{m+2}}{m+2}$. The diſtance of the centre of gravity from L is had by dividing this momentum by the whole weight which is $\frac{x^{m+1}}{m+1}$. The quotient or g is $\frac{x \times \overline{m+1}}{m+2}$. And the diſtance of the centre of gravity from the ſection Bb is $x - \frac{x \times \overline{m+1}}{m+2}, = \frac{x \times \overline{m+2} - x \times \overline{m+1}}{m+2}, = \frac{x}{m+2}$. Therefore the ſtrain on the ſection Bb is had by multiplying $\frac{x^{m+1}}{m+1}$ by $\frac{x}{m+2}$. The product is $\frac{x^{m+2}}{\overline{m+2} \times \overline{m+1}}$. This muſt be as the ſquare of the depth, or as y^2. But y is as x^m, and y^2 as x^{2m}. Therefore we have $m+2 = 2m$, and $m = 2$; that is, the depth muſt be as the ſquare of the diſtance from the extremity, and the curve $Lb\,A$ is a parabola touching the horizontal line in L.

99 A conoid equally able in every ſection to bear its own weight.

It is eaſy to ſee that a conoid formed by the rotation of this figure round DL will alſo be equally able in every ſection to bear its own weight.

We need not proſecute this farther. When the figure of the piece is given, there is no difficulty in finding the ſtrain; and the circumſtance of equal ſtrength to reſiſt this ſtrain is chiefly a matter of curioſity.

100 The more a beam projects, the leſs able it is to bear its own weight.

It is evident, from what has been already ſaid, that a projecting beam becomes leſs able to bear its own weight, as it projects farther. Whatever may be the ſtrength of the ſection DA, the length may be ſuch that it will break by its own weight. If we ſuppoſe two beams A and B of the ſame ſubſtance and ſimilar ſhapes, that is, having their lengths and diameters in the ſame proportion; and farther ſuppoſe that the ſhorter can juſt bear its own weight; then the longer beam will not be able to do the ſame: For the ſtrengths of the ſections are as the cubes of the diameters, while the ſtrains are as the biquadrates of the diameters; becauſe the weights are as the cubes, and the levers by which theſe weights act in producing the ſtrain are as the lengths or as the diameters.

Theſe conſiderations ſhow us, that in all caſes where ſtrain is affected by the weight of the parts of the machine or ſtructure of any kind, the ſmaller bodies are more able to withſtand it than the greater; and there ſeems to be bounds ſet by nature to the ſize of machines conſtructed of any given materials. Even when the weight of the parts of the machine is not taken into the account, we cannot enlarge them in the ſame proportion in all their parts. Thus a ſteam-engine cannot be doubled in all its parts, ſo as to be ſtill efficient. The preſſure on the piſton is quadrupled. If the lift of the pump be alſo doubled in height while it is doubled in diameter, the load will be increaſed eight times, and will therefore exceed the power. The depth of lift, therefore, muſt remain unchanged; and in this caſe the machine will be of the ſame relative ſtrength as before, independent of its own weight. For the beam being doubled in all its dimenſions, its momentum of coheſion is eight times greater, which is again a balance for a quadruple load acting by a double lever.—But if we now conſider the increaſe of the weight of the machine itſelf, which muſt be ſupported, and which muſt be put in motion by the intervention of its coheſion, we ſee that the large machine is weaker and leſs efficient than the ſmall one.

101 Small bodies more able to withſtan the ſtrain produced by the weight of the machine than great bodies.

There is a ſimilar limit ſet by nature to the ſize of plants and animals formed of the ſame matter. The coheſion of an herb could not ſupport it if it were increaſed to the ſize of a tree, nor could an oak ſupport itſelf if 40 or 50 times bigger, nor could an animal of the make of a long-legged ſpider be increaſed to the ſize of a man; the articulations of its legs could not ſupport it.

102 Even ſmall animals are remarkable for ſtrength and agility.

Hence may be underſtood the prodigious ſuperiority of the ſmall animals both in ſtrength and agility. A man by falling twice his own height may break his firmeſt bones. A mouſe may fall 20 times its height without riſk; and even the tender mite or wood-louſe may fall unhurt from the top of a ſteeple. But their greateſt ſuperiority is in reſpect of nimbleneſs and agility. A flea can leap above 500 times its own length, while the ſtrength of the human muſcles could not raiſe the trunk from the ground on limbs of the ſame conſtruction.

The angular motions of ſmall animals (in which conſiſts their nimbleneſs or agility) muſt be greater than thoſe of large animals, ſuppoſing the force of the muſcular fibre to be the ſame in both. For ſuppoſing them ſimilar, the number of equal fibres will be as the ſquare of their linear dimenſions; and the levers by which they act are as their linear dimenſions. The energy therefore of the moving force is as the cube of theſe dimenſions. But the momentum of inertia, or $\int p.r^2$, is as the 4th power: Therefore the angular velocity of the greater animals is ſmaller. The number of ſtrokes which a fly makes with its wings in a ſecond is aſtoniſhingly great; yet, being voluntary, they are the effects of its agility.

We have hitherto confined our attention to the ſimpleſt form in which this tranſverſe ſtrain can be produced. This was quite ſufficient for ſhowing us the mechaniſm of nature by which the ſtrain is reſiſted; and a very ſlight attention is ſufficient for enabling us to reduce to this every other way in which the ſtrain can be produced. We ſhall not take up the reader's time with the application of the ſame principles to other caſes of this ſtrain, but refer him to what has been ſaid in the article Roofs. In that article we have ſhown the analogy between the ſtrain on the ſection of a beam projecting from a wall and loaded at the extremity, and the ſtrain

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strain on the same section of a beam simply resting on supports at the ends, and loaded at some intermediate point or points. The strain on the middle C of a beam AB (fig. 22.) so supported, arising from a weight laid on there, is the same with the strain which half that weight hanging at B would produce on the same section C if the other end of the beam were fixed in a wall. If therefore 1000 pounds hung on the end of a beam projecting 10 feet from a wall will just break it at the wall, it will require 4000 pounds on its middle to break the same beam resting on two props 10 feet asunder. We have also shown in that article the additional strength which will be given to this beam by extending both ends beyond the props, and there framing it firmly into other pillars or supports. We can hardly add any thing to what has been said in that article, except a few observations on the effects of the obliquity of the external force. We have hitherto supposed it to act in the direction BP (fig. 8.) perpendicular to the length of the beam. Suppose it to act in the direction BP′, oblique to BA. In the article Roof we supposed the strain to be the same as if the force p acted at the distance AB′, but still perpendicular to AB: so it is. But the strength of the section A Δ is not the same in both cases; for by the obliquity of the action the piece DCKΔ is pressed to the other. We are not sufficiently acquainted with the corpuscular forces to say precisely what will be the effect of the pressure arising from this obliquity; but we can clearly see, in general, that the point A, which in the instant of fracture is neither stretched nor compressed, must now be farther up, or nearer to D; and therefore the number of particles which are exerting cohesive forces is smaller, and therefore the strength is diminished. Therefore, when we endeavour to proportion the strength of a beam to the strain arising from an external force acting obliquely, we make too liberal allowance by increasing this external force in the ratio of AB to AB. We acknowledge our inability to assign the proper correction. But this circumstance is of very great influence. In many machines, and many framings of carpentry, this oblique action of the straining force is unavoidable; and the most enormous strains to which materials are exposed are generally of this kind. In the frames set up for carrying the ringstones of arches, it is hardly possible to avoid them: for although the judicious engineer disposes his beams so as to sustain only pressures in the direction of their lengths, tending either to crush them or to tear them asunder, it frequently happens that, by the settling of the work, the pieces come to check and bear on each other transversely, tending to break each other across. This we have remarked upon in the article Roofs, with respect to a truss by Mr Price (see Roofs, N° 40, 41, 45). Now when a cross strain is thus combined with an enormous pressure in the direction of the length of the beam, it is in the utmost danger of snapping suddenly across. This is one great cause of the carrying away of masts. They are compressed in the direction of their length by the united force of the shrouds, and in this state the transverse action of the wind soon completes the fracture.

Fig. 22.

103 Effects of the obliquity of the external force.

104 The strain on columns.

When considering the compressing strains to which materials are exposed, we deferred the discussion of the strain on columns, observing that it was not, in the cases which usually occur, a simple compression, but was combined with a transverse strain, arising from the bending of the column. When the column ACB (fig. 23.) resting on the ground at B, and loaded at top with a weight A, acting in the vertical direction AB, is bent into a curve ACB, so that the tangent at C is perpendicular to the horizon, its condition somewhat resembles that of a beam firmly fixed between B and C, and strongly pulled by the end A, so as to bend it between C and A. Although we cannot conceive how a force acting on a straight column AB in the direction AB can bend it, we may suppose that the force acted first in the horizontal direction A b till it was bent to this degree, and that the rope was then gradually removed from the direction A b to the direction AB, increasing the force as much as is necessary for preserving the same quantity of flexure.

Fig. 23.

105 Observations on Euler's theory of the strength of columns.

The first author (we believe) who considered this important subject with scrupulous attention was the celebrated Euler, who published in the Berlin Memoirs for 1757 his Theory of the Strength of Columns. The general proposition established by this theory is, that the strength of prismatical columns is in the direct quadruplicate ratio of their diameters, and the inverse duplicate ratio of their lengths. He prosecuted this subject in the Petersburgh Commentaries for 1778, confirming his former theory. We do not find that any other author has bestowed much attention on it, all seeming to acquiesce in the determinations of Euler, and to consider the subject as of very great difficulty, requiring the application of the most refined mathematics. Muschenbroek has compared the theory with experiment; but the comparison has been very unsatisfactory, the difference from the theory being so enormous as to afford no argument for its justness. But the experiments do not contradict it, for they are so anomalous as to afford no conclusion or general rule whatever.

To say the truth, the theory can be considered in no other light than as a specimen of ingenious and very artful algebraic analysis. Euler was unquestionably the first analyst in Europe for resource and address. He knew this, and enjoyed his superiority, and without scruple admitted any physical assumptions which gave him an opportunity of displaying his skill. The inconsistency of his assumptions with the known laws of mechanism gave him no concern; and when his algebraic processes led him to any conclusion which would make his readers stare, being contrary to all our usual notions, he frankly owned the paradox, but went on in his analysis, saying, "*Sed analysi magis fidendum.*" Mr Robins has given some very risible instances of this confidence in his analysis, or rather of his confidence in the indolent submission of his readers. Nay, so fond was he of this kind of amusement, that after having published an untenable Theory of Light and Colours, he published several Memoirs, explaining the aberration of the heavenly bodies, and deducing some very wonderful consequences, fully confirmed by experience, from the Newtonian principles, which were opposite and totally inconsistent with his own theory, merely because the Newtonian theory gave him "*occasionem analyseos promovendæ.*" We are thus severe in our observations, because his theory of the strength of columns is one of the strongest instances of this wanton kind of proceeding, and because his followers in the Academy of St Petersburgh, such as Mr Fuss, Lexill, and others, adopt his conclusions, and merely echo his words. Since the death of Daniel Bernoulli

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Bernoulli no member of that academy has controverted any thing advanced by their *Professor sublimis geometriæ*, to whom they had been indebted for their places and for all their knowledge, having been (most of them) his amanuenses, employed by this wonderful man during his blindness to make his computations and carry on his algebraic investigations. We are not a little surprised to see Mr Emerson, a considerable mathematician, and a man of very independent spirit, hastily adopting the same theory, of which we doubt not but our readers will easily see the falsity.

Fig. 23.

Euler considers the column ACB as in a condition precisely similar to that of an elastic rod bent into the curve by a cord AB connecting its extremities.—In this he is not mistaken.—But he then draws CD perpendicular to AB, and considers the strain on the section C as equal to the momentum or mechanical energy of the weight A acting in the direction DB upon the lever $x\,c$ D, moveable round the fulcrum c, and tending to tear asunder the particles which cohere along the section c C x. This is the same principle (as Euler admits) employed by James Bernoulli in his investigation of the elastic curve ACB. Euler considers the strain on the section $c\,x$ as the same with what it would sustain if the same power acted in the horizontal direction EF on a point E as far removed from C as the point D is. We reasoned in the same manner (as has been observed) in the article Roofs, where the obliquity of action was inconsiderable. But in the present case, this substitution leads to the greatest mistakes, and has rendered the whole of this theory false and useless. It would be just if the column were of materials which are incompressible. But it is evident, by what has been said above, that by the compression of the parts the real fulcrum of the lever shifts away from the point c, so much the more as the compression is greater. In the great compressions of loaded columns, and the almost unmeasurable compressions of the truss beams in the centres of bridges, and other cases of chief importance, the fulcrum is shifted far over towards x, so that very few fibres resist the fracture by their cohesion; and these few have a very feeble energy or momentum, on account of the short arm of the lever by which they act. This is a most important consideration in carpentry, yet makes no element of Euler's theory. The consequence of this is, that a very small degree of curvature is sufficient to cause the column or strutt to snap in an instant, as is well known to every experienced carpenter. The experiment by Muschenbroek, which Euler makes use of in order to obtain a measure of strength in a particular instance, from which he might deduce all others by his theorem, is an incontestable proof of this. The force which broke the column is not the twentieth part of what is necessary for breaking it by acting at E in the direction EF. Euler takes no notice of this immense discrepancy, because it must have caused him to abandon the speculation with which he was then amusing himself.

106
This theory false and useless.

The limits of this work do not afford room to enter minutely upon the refutation of this theory; but we can easily show its uselessness, by its total inconsistency with common observation. It results legitimately from this theory, that if CD have no magnitude, the weight A can have no momentum, and the column cannot be broken —True,—it cannot be broken in this way, snapped by a transverse fracture, if it do not bend; but we know very well that it can be crushed or crippled, and we see this frequently happen. This circumstance or event does not enter into Euler's investigation, and therefore the theory is imperfect at least and useless. Had this crippling been introduced in the form of a physical assumption, every topic of reasoning employed in the process must have been laid aside, as the intelligent reader will easily see. But the theory is not only imperfect, but false. The ordinary reader will be convinced of this by another legitimate consequence of it. Fig 24. is the same with fig. 106. of *Emerson's Mechanics*, where this subject is treated on Euler's principles, and represents a crooked piece of matter resting on the ground at F, and loaded at A with a weight acting in the vertical direction AF. It results from Euler's theory that the strains at b, B, D, E, &c. are as bc, BC, DI, EK, &c. Therefore the strains at G and H are nothing; and this is asserted by Emerson and Euler as a serious truth; and the piece may be thinned *ad infinitum* in these two places, or, even cut through, without any diminution of its strength. The absurdity of this assertion strikes at first hearing. Euler asserts the same thing with respect to a point of contrary flexure. Farther discussion is (we apprehend) needless. Fig. 24.

107
Yet Euler's dissertations deserve a perusal.

This theory must therefore be given up. Yet these dissertations of Euler in the Petersburgh Commentaries deserve a perusal, both as very ingenious specimens of analysis, and because they contain maxims of practice which are important. Although they give an erroneous measure of the comparative strength of columns, they show the immense importance of preventing all bendings, and point out with accuracy where the tendencies to bend are greatest, and how this may be prevented by very small forces, and what a prodigious accession of force this gives the column. There is a valuable paper in the same volume by Fuss *on the Strains on framed Carpentry*, which may also be read with advantage.

108
A new theory cannot be substituted in place of Euler's, till many experiments be made.

It will now be asked, what shall be substituted in place of this erroneous theory? what is the true proportion of the strength of columns? We acknowledge our inability to give a satisfactory answer. Such can be obtained only by a previous knowledge of the proportion between the extensions and compressions produced by equal forces, by the knowledge of the absolute compressions producible by a given force, and by a knowledge of the degree of that derangement of parts which is termed crippling. These circumstances are but imperfectly known to us, and there lies before us a wide field of experimental inquiry. Fortunately the force requisite for crippling a beam is prodigious, and a very small lateral support is sufficient to prevent that bending which puts the beam in imminent danger. A judicious engineer will always employ transverse bridles, as they are called, to stay the middle of long beams, which are employed as pillars, strutts, or truss beams, and are exposed, by their position, to enormous pressures in the direction of their lengths. Such stays may be observed, disposed with great judgement and economy, in the centres employed by Mr Perronet in the erection of his great stone arches. He was obliged to correct this omission made by his ingenious predecessor in the beautiful centres of the bridge of Orleans, which we have no hesitation in affirming to be the finest piece of carpentry in the world.

It

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It only remains on this head to compare these theoretical deductions with experiment.

Experiments on the transverse strength of bodies are easily made, and accordingly are very numerous, especially those made on timber, which is the case most common and most interesting. But in this great number of experiments there are very few from which we can draw much practical information. The experiments have in general been made on such small scantlings, that the unavoidable natural inequalities bear too great a proportion to the strength of the whole piece. Accordingly, when we compare the experiments of different authors, we find them differ enormously, and even the experiments by the same author are very anomalous. The completest series that we have yet seen is that detailed by Belidor in his *Science des Ingenieurs*. They are contained in the following table. The pieces were found, even-grained oak. The column b contains the breadths of the pieces in inches; the column d contains their depths; the column l contains their lengths; column p contains the weights (in pounds) which broke them when hung on their middles; and m is the column of averages or mediums.

109 Table of experiments made by Belidor.

N°	b	d	l	p	m	
1	1	1	18	400 415 405	406	The ends lying loose.
2	1	1	18	600 600 624	608	The ends firmly fixed.
3	2	1	18	810 795 812	805	Loose.
4	1	2	18	1570 1580 1590	1580	Loose.
5	1	1	36	185 195 180	187	Loose.
6	1	1	36	285 280 285	283	Fixed.
7	2	2	36	1550 1620 1585	1585	Loose.
8	$2\frac{1}{2}$	$2\frac{1}{2}$	36	1665 1675 1640	1660	Loose.

110 Corollaries deduced from them.

By comparing Experiments 1st and 3d, the strength appears proportional to the breadth.

Experiments 3d and 4th shew the strength proportional to the square of the depth.

Experiments 1st and 5th shew the strength nearly in the inverse proportion of the lengths, but with a sensible deficiency in the longer pieces.

Experiments 5th and 7th shew the strengths proportional to the breadths and the square of the depth.

Experiments 1st and 7th shew the same thing, compounded with the inverse proportion of the length: the deficiency relative to the length is not so remarkable here.

Experiments 1st and 2d, and experiments 5th and 6th shew the increase of strength, by fastening the ends, to be in the proportion of 2 to 3. The theory gives the proportion of 2 to 4. But a difference in the manner of fixing may produce this deviation from the theory, which only supposed them to be held down at places beyond the props, as when a joist is held in the walls, and also rests on two pillars between the walls. (See what is said on this subject in the article Roof, § 19.); where note, that there is a mistake, when it is said that a beam supported at both ends and loaded in the middle, will carry twice as much as if one end were fixed in the wall and the weight suspended at the other end. The reasoning employed there shows that it will carry four times as much.

The chief source of irregularity in such experiments is the fibrous, or rather plated texture of timber. It consists of annual additions, whose cohesion with each other is vastly weaker than that of their own fibres. Let fig. 25. represent the section of a tree, and ABCD, Fig. 25. $a\,b\,c\,d$ the section of two battens that are to be cut out of it for experiment, and let AD and $a\,d$ be the depths, and DC, $d\,c$ the breadths. The batten ABCD will be the strongest, for the same reason that an assemblage of planks set edgewise will form a stronger joist than planks laid above each other like the plates of a coach-spring. M. Buffon found by many trials that the strength of ABCD was to that of $a\,b\,c\,d$ (in oak) nearly as 8 to 7. The authors of the different experiments were not careful that their battens had their plates all disposed similarly with respect to the strain. But even with this precaution they would not have afforded sure grounds of computation for large works; for great beams occupy much, if not the whole, of the section of the tree; and from this it has happened that their strength is less than in proportion to that of a small lath or batten. In short, we can trust no experiments but such as have been made on large beams. These must be very rare, for they are most expensive and laborious, and exceed the abilities of most of those who are disposed to study this matter.

But we are not wholly without such authority. M. Buffon and M. Du Hamel, two of the first philosophers and mechanicians of the age, were directed by government to make experiments on this subject, and were supplied with ample funds and apparatus. The relation of their experiments is to be found in the Memoirs of the French Academy for 1740, 1741, 1742, 1768; as also in Du Hamel's valuable performances *sur l'Exploitation des Arbres, et sur la Conservation et le Transport de Bois*. We earnestly recommend these dissertations to the perusal of our readers, as containing much useful information relative to the strength of timber, and the best methods of employing it. We shall here give an abstract of M. Buffon's experiments.

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111
Mr Buffon's experiments on bars of found oak.

He relates a great number which he had profecuted during two years on fmall battens. He found that the odds of a fingle layer, or part of a layer, more or lefs, or even a different difpofition of them, had fuch influence that he was obliged to abandon this method, and to have recourfe to the largeft beams that he was able to break. The following table exhibits one feries of experiments on bars of found oak, clear of knots, and four inches fquare. This is a fpecimen of all the reft.

Column 1ft is the length of the bar in clear feet between the fupports.

Column 2d is the weight of the bar (the 2d day after it was felled) in pounds. Two bars were tried of each length. Each of the firft three pairs confifted of two cuts of the fame tree. The one next the root was always found the heavieft, ftiffeft, and ftrongeft. Indeed M. Buffon fays that this was invariably true, that the heavieft was always the ftrongeft; and he recommends it as certain (or fure) rule for the choice of timber. He finds that this is always the cafe when the timber has grown vigoroufly, forming very thick annual layers. But he alfo obferves that this is only during the advances of the tree to maturity; for the ftrength of the different circles approaches gradually to equality during the tree's healthy growth, and then it decays in thefe parts in a contrary order. Our tool-makers affert the fame thing with refpect to beech: yet a contrary opinion is very prevalent; and wood with a fine, that is, a fmall grain, is frequently preferred. Perhaps no perfon has ever made the trial with fuch minutenefs as M. Buffon, and we think that much deference is due to his opinion.

Column 3d is the number of pounds neceffary for breaking the tree in the courfe of a few minutes.

Column 4th is the inches which it bent down before breaking.

Column 5th is the time at which it broke.

1	2	3	4	5
7	60	5350	3.5	29
	56	5275	4.5	22
8	68	4600	3.75	15
	63	4500	4.7	13
9	77	4100	4.85	14
	71	3950	5.5	12
10	84	3625	5.83	15
	82	3600	6.5	15
12	100	3050	7.	
	98	2925	8.	

The experiments on other fizes were made in the fame way. A pair at leaft of each length and fize was taken. The mean refults are contained in the following table. The beams were all fquare, and their fizes in inches are placed at the head of the columns, and their lengths in feet are in the firft column.

	4	5	6	7	8	A
7	5312	11525	18950	32200	47649	11525
8	4550	9787	15525	26050	39750	10085
9	4025	8308	13150	22350	32800	8964
10	3612	7125	11250	19475	27750	8068
12	2987	6075	9100	16175	23450	6723
14		5300	7475	13225	19775	5763
16		4350	6362	11000	16375	5042
18		3700	5562	9245	13200	4482
20		3225	4950	8375	11487	4034
22		2975				3667
24		2162				3362
28		1775				2881

M. Buffon had found by numerous trials that oak-timber loft much of its ftrength in the courfe of drying or feafoning; and therefore, in order to fecure uniformity, his trees were all felled in the fame feafon of the year, were fquared the day after, and tried the third day. Trying them in this green ftate, gave him an opportunity of obferving a very curious and unaccountable phenomenon. When the weights were laid brifkly on, nearly fufficient to break the log, a very fenfible fmoke was obferved to iffue from the two ends with a fharp hiffing noife. This continued all the while the tree was bending and cracking. This fhows that the log is affected or ftrained through its whole length; indeed this muft be inferred from its bending through its whole length. It alfo fhows us the great effects of the compreffion. It is a pity M. Buffon did not take notice whether this fmoke iffued from the upper or compreffed half of the fection only, or whether it came from the whole. 112

Obfervations on Mr Buffon's experiments.

We muft now make fome obfervations on thefe experiments, in order to compare them with the theory which we have endeavoured to eftablifh.

M. Buffon confiders the experiments with the 5-inch bars as the ftandard of comparifon, having both extended thefe to greater lengths, and having tried more pieces of each length.

Our theory determines the relative ftrength of bars of the fame fection to be inverfely as their lengths. But (if we except the five experiments in the firft column) we find a very great deviation from this rule. Thus the 5-inch bar of 28 feet long fhould have half the ftrength of that of 14 feet, or 2650; whereas it is but 1775. The bar of 14 feet fhould have half the ftrength of that of 7 feet, or 5762; whereas it is but 5300. In like manner, the fourth of 11525 is 2881; but the real ftrength of the 28 feet bar is 1775. We have added a column A, which exhibits the ftrength which each of the 5-inch bars ought to have by the theory. This deviation is moft diftinctly feen in fig. 26. where BK is the fcale of lengths, B being at the point 7 of the fcale, and K at 28. The ordinate CB is $= 11525$, and the other ordinates DE, GK, &c. are refpectively $= \frac{7\,CB}{\text{Length}}$. Fig. 26

The lines DF, GH, &c. are made $= 4350$, 1775, &c. expreffing the ftrengths given by experiment. The 10 feet bar and the 24 feet bar are remarkably anomalous. But all are deficient, and the defect has an evident progreffion from the firft to the laft. The fame thing may be

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be shown of the other columns, and even of the first, though it is very small in that column. It may also be observed in the experiments of Belidor, and in all that we have seen. We cannot doubt therefore of its being a law of nature, depending on the true principles of cohesion, and the laws of mechanics.

But it is very puzzling, and we cannot pretend to give a satisfactory explanation of the difficulty. The only effect which we can conceive the length of a beam to have, is to increase the strain at the section of fracture by employing the intervening beam as a lever. But we do not distinctly see what change this can produce in the mode of action of the fibres in this section, so as either to change their cohesion or the place of its centre of effort: yet something of this kind must happen.

We see indeed some circumstances which must contribute to make a smaller weight sufficient, in Mr Buffon's experiments, to break a long beam, than in the exact inverse proportion of its length.

In the first place, the weight of the beam itself augments the strain as much as if half of it were added in form of a weight. Mr Buffon has given the weights of every beam on which he made experiments, which is very nearly 74 pounds per cubic foot. But they are much too small to account for the deviation from the theory. The half weights of the 5-inch beams of 7, 14, and 28 feet length are only 45, 92, and 182 pounds; which makes the real strains in the experiments 11560, 5390, and 1956; which are far from having the proportions of 4, 2, and 1.

Buffon says that healthy trees are universally strongest at the root end; therefore, when we use a longer beam, its middle point, where it is broken in the experiment, is in a weaker part of the tree. But the trials of the 4-inch beams show that the difference from this cause is almost insensible.

The length must have some mechanical influence which the theory we have adopted has not yet explained. It may not however be inadequate to the task. The very ingenious investigation of the elastic curve by James Bernoulli and other celebrated mathematicians is perhaps as refined an application of mathematical analysis as we know. Yet in this investigation it was necessary, in order to avoid almost insuperable difficulties, to take the simplest possible case, viz. where the thickness is exceedingly small in comparison with the length. If the thickness be considerable, the quantities neglected in the calculus are too great to permit the conclusion to be accurate, or very nearly so. Without being able to define the form into which an elastic body of considerable thickness will be bent, we can say with confidence, that in an extreme case, where the compression in the concave side is very great, the curvature differs considerably from the Bernoullian curve. But as our investigation is incomplete and very long, we do not offer it to the reader. The following more familiar considerations will, we apprehend, render it highly probable that the relative strength of beams decreases faster than in the inverse ratio of their length. The curious observation by Mr Buffon of the vapour which issued with a hissing noise from the ends of a beam of green oak, while it was breaking by the load on its middle, shows that the whole length of the piece was affected: indeed it must be, since it is bent throughout. We have shown above, that a certain definite curvature of a beam of a given form is always accompanied by rupture. Now suppose the beam A of 10 feet long, and the beam B of 20 feet long, bent to the same degree, at the place of their fixture in the wall; the weight which hangs on A is nearly double of that which must hang on B. The form of any portion, suppose 5 feet, of these two beams, immediately adjoining to the wall, is considerably different. At the distance of 5 feet the curvature of A is $\frac{1}{2}$ of its curvature at the wall. The curvature of B in the corresponding point is $\frac{3}{4}$ths of the same curvature at the wall. Through the whole of the intermediate 5 feet, therefore, the curvature of B is greater than that of A. This must make it weaker throughout. It must occasion the fibres to slide more on each other (that it may acquire *this* greater curvature), and thus affect their lateral union; and therefore those which are stronger will not assist their weaker neighbours. To this we must add, that in the shorter beams the force with which the fibres are pressed laterally on each other is double. This must impede the mutual sliding of the fibres which we mentioned a little ago; nay, this lateral compression may change the law of longitudinal cohesion (as will readily appear to the reader who is acquainted with Boscovich's doctrines), and increase the strength of the very surface of fracture, in the same way (however inexplicable) as it does in metals when they are hammered or drawn into wire.

113 Probable that the relative strength of beams decreases faster than in the inverse ratio of their length.

The reader must judge how far these remarks are worthy of his attention. The engineer will carefully keep in mind the important fact, that a beam of quadruple length, instead of having $\frac{1}{4}$th of the strength, has only about $\frac{1}{6}$th; and the philosopher should endeavour to discover the cause of this diminution, that he may give the artist a more accurate rule of computation.

114 We cannot discover the precise relation between the curvature and the momentum of cohesion.

Our ignorance of the law by which the cohesion of the particles changes by a change of distance, hinders us from discovering the precise relation between the curvature and the momentum of cohesion; and all we can do is to multiply experiments, upon which we may establish some *empirical* rules for calculating the strength of solids. Those from which we must reason at present are too few and too anomalous to be the foundation of such an empirical formula. We may, however, observe, that Mr Buffon's experiments give us considerable assistance in this particular: For if to each of the numbers of the column for the 5-inch beams, corrected by adding half the weight of the beam, we add the constant number 1245, we shall have a set of numbers which are very nearly reciprocals of the lengths. Let 1245 be called c, and let the weight which is known by experiment to be necessary for breaking the 5-inch beam of the length a be called P. We shall have $\frac{\overline{P+c}\times a}{l}-c=p$. Thus the weight necessary for breaking the 7-foot bar is 11560. This added to 1245, and the sum multiplied by 7, gives $\overline{P+c}\times a=89635$. Let l be 18; then $\frac{89635}{18}-1245=3725,=p$, which differs not more than $\frac{1}{37}$th from what experiment gives us. This rule holds equally well in all the other lengths except the 10 and 24 foot beams, which are very anomalous. Such a formula is abundantly exact for practice, and will answer through a much greater variety of length, though it cannot be admitted as a true one; because, in a certain very great

length,

length, the strength will be nothing. For other sizes the constant number must change in the proportion of d^3, or perhaps of p.

115 Relation between the strength and the square of the depth of the section.

The next comparison which we have to make with the theory is the relation between the strength and the square of the depth of the section. This is made by comparing with each other the numbers in any horizontal line of the table. In making this comparison we find the numbers of the five-inch bars uniformly greater than the rest. We imagine that there is something peculiar to these bars: They are in general heavier than in the proportion of their section, but not so much so as to account for all their superiority. We imagine that this set of experiments, intended as a standard for the rest, has been made at one time, and that the season has had a considerable influence. The fact however is, that if this column be kept out, or uniformly diminished about one-sixteenth in their strength, the different sizes will deviate very little from the ratio of the square of the depth, as determined by theory. There is however a small deficiency in the bigger beams.

We have been thus anxious in the examination of these experiments, because they are the only ones which have been related in sufficient detail, and made on a proper scale for giving us data from which we can deduce confidential maxims for practice. They are so troublesome and expensive that we have little hopes of seeing their number greatly increased; yet surely our navy board would do an unspeakable service to the public by appropriating a fund for such experiments under the management of some man of science.

116 Proportion between the absolute cohesion and the relative strength.

There remains another comparison which is of chief importance, namely, the proportion between the ABSOLUTE COHESION and the RELATIVE STRENGTH. It may be guessed, from the very nature of the thing, that this must be very uncertain. Experiments on the absolute strength must be confined to very small pieces, by reason of the very great forces which are required for tearing them asunder. The values therefore deduced from them must be subject to great inequalities. Unfortunately we have got no detail of any experiments; all that we have to depend on is two passages of Muschenbroek's *Essais de Physique;* in one of which he says that a piece of sound oak $\frac{2}{100}$ths of an inch square is torn asunder by 1150 pounds; and in the other, that an oak plank 12 inches broad and one thick will just suspend 189163 pounds. These give for the cohesion of an inch square 15,755 and 15,763 pounds. Bouguer, in his *Traité du Navire*, says that it is very well known that a rod of sound oak one fourth of an inch square will be torn asunder by 1000 pounds. This gives 16000 for the cohesion of a square inch. We shall take this as a round number, easily used in our computations. Let us compare this with M. Buffon's trials of beams four inches square.

The absolute cohesion of this section is $16,000 \times 16 = 256,000$. Did every fibre exert its whole force in the instant of fracture, the momentum of cohesion would be the same as if it had all acted at the centre of gravity of the section at 2 inches from the axis of fracture, and is therefore 512000. The 4-inch beam, 7 feet long, was broken by 5312 pounds hung on its middle. The half of this, or 2656 pounds, would have broken it, if suspended at its extremity, projecting $3\frac{1}{2}$ feet or 42 inches from a wall. The momentum of this strain is therefore $2656 \times 42, = 111552$. Now this is in equilibrio with the actual momentum of cohesion, which is therefore 111552, instead of 512000. The strength is therefore diminished in the proportion of 512000 to 111552, or very nearly of 4,59 to 1.

As we are quite uncertain as to the place of the centre of effort, it is needless to consider the full cohesion as acting at the centre of gravity, and producing the momentum 512,000; and we may convert the whole into a simple multiplier m of the length, and say, *as* m *times the length is to the depth, so is the absolute cohesion of the section to the relative strength.* Therefore let the absolute cohesion of a square inch be called f, the breadth b, the depth d, and the length l (all in inches), the relative strength, or the external force p, which balances it, is $\frac{f b d^2}{9,18 l}$, or in round numbers $\frac{f b d^2}{9 l}$; for $m = 2 \times 4,59$.

This great diminution of strength cannot be wholly accounted for by the inequality of the cohesive forces exerted in the instant of fracture; for in this case we know that the centre of effort is at $\frac{1}{3}$d of the height in a rectangular section (because the forces really exerted are as the extensions of the fibres). The relative strength would be $\frac{f b d^2}{3 l}$, and p would have been 8127 instead of 2656.

We must ascribe this diminution (which is three times greater than that produced by the inequality of the cohesive forces) to the compression of the under part of the beam; and we must endeavour to explain in what manner this compression produces an effect which seems so little explicable by such means.

As we have repeatedly observed, it is a matter of nearly universal experience that the forces *actually* exerted by the particles of bodies, when stretched or compressed, are very nearly in the proportion of the distances to which the particles are drawn from their natural positions. Now, although we are certain that, in enormous compressions, the forces increase faster than in this proportion, this makes no sensible change in the present question, because the body is broken before the compressions have gone so far; nay, we imagine that the compressed parts are crippled in most cases even before the extended parts are torn asunder. Muschenbroek asserts this with great confidence with respect to oak, on the authority of his own experiments. He says, that although oak will suspend half as much again as fir, it will not support, as a pillar, two-thirds of the load which fir will support in that form.

We imagine therefore that the mechanism in the *present* case is nearly as follows:

Let the beam DCKΔ (fig. 27.) be loaded at its extremity with the weight P, acting in the direction KP perpendicular to DC. Let DΔ be the section of fracture. Let DA be about one-third of DΔ. A will be the particle or fibre which is neither extended nor compressed. Make $\Delta \delta : D d = DA : A\Delta$. The triangles DAd, $\Delta A \delta$, will represent the accumulated attracting and repelling forces. Make AI and $A i = \frac{1}{3}$DA and $\frac{1}{3} \Delta A$. The point I will be that to which the full cohesion Dd or f of the particles in AD must be applied, so as to produce the same momentum which the variable forces at I, D, &c. really produce at their several points Fig. 27.

of

of application. In like manner, i is the centre of similar effort of the repulsive forces excited by the compression between A and Δ, and it is the real fulcrum of a bended lever I i K, by which the whole effect is produced. The effect is the same as if the full cohesion of the stretched fibres in AD were accumulated in I, and the full repulsion of all the compressed fibres in A Δ were accumulated in i. The forces which are balanced in the operation are the weight P, acting by the arm k i, and the full cohesion of AD acting by the arm I i. The forces exerted by the compressed fibres between A and Δ only serve to give support to the lever, that it may exert its strain.

We imagine that this does not differ much from the real procedure of nature. The position of the point A may be different from what we have deduced from Mr Buffon's experiments, compared with Muschenbroek's value of the absolute cohesion of a square inch. If this last should be only 12000, DA must be greater than we have here made it, in the proportion of 12000 to 16000. For I i must still be made $=\frac{2}{3}$ A Δ, supposing the forces to be proportional to the extensions and compressions. There can be no doubt that a part only of the cohesion of D Δ operates in resisting the fracture in all substances which have any compressibility; and it is confirmed by the experiments of Mr Du Hamel on willow, and the inferences are by no means confined to that species of timber. We say therefore, that when the beam is broken, the cohesion of AD alone is exerted, and that each fibre exerts a force proportional to its extension; and the accumulated momentum is the same as if the full cohesion of AD were acting by the lever I i $=\frac{1}{3}$d of D Δ.

It may be said, that if only one-third of the cohesion of oak be exerted, it may be cut two-thirds through without weakening it. But this cannot be, because the cohesion of the whole is employed in preventing the lateral slide so often mentioned. We have no experiments to determine that it *may not* be cut through one-third without loss of its strength.

This must not be considered as a subject of mere speculative curiosity. It is intimately connected with all the practical uses which we can make of this knowledge; for it is almost the only way that we can learn the compressibility of timber. Experiments on the direct cohesion are indeed difficult, and exceedingly expensive if we attempt them in large pieces. But experiments on compression are almost impracticable. The most instructive experiments would be, first to establish, by a great number of trials, the transverse force of a modern batten; and then to make a great number of trials of the diminution of its strength, by cutting it through on the concave side. This would very nearly give us the proportion of the cohesion which really operates in resisting fractures. Thus if it be found that one-half of the beam may be cut on the under side without diminution of its strength (taking care to drive in a slice of harder wood), we may conclude that the point A is at the middle, or somewhat above it.

Much lies before the curious mechanician, and we are as yet very far from a scientific knowledge of the strength of timber.

In the mean time, we may derive from these experiments of Buffon a very useful practical rule, without relying on any value of the absolute cohesion of oak. We see that the strength is nearly as the breadth, as the square of the depth, and as the inverse of the length. It is most convenient to measure the breadth and depth of the beam in inches, and its length in feet. Since, then, a beam four inches square and seven feet between the supports is broken by 5312 pounds, we must conclude that a batten one inch square and one foot between the supports will be broken by 581 pounds. Then the strength of any other beam of oak, or the weight which will just break it when hung on its middle, is $581\frac{b\,d^2}{l}$.

117 A useful practical rule may be deduced from Mr Buffon's experiments.

But we have seen that there is a very considerable deviation from the inverse proportion of the lengths, and we must endeavour to accommodate our rule to this deviation. We found, that by adding 1245 to each of the ordinates or numbers in the column of the five-inch bars, we had a set of numbers very nearly reciprocal of the lengths; and if we make a similar addition to the other columns in the proportion of the cubes of the sixes, we have nearly the same result. The greatest error (except in the case of experiments which are very irregular) does not exceed $\frac{1}{15}$th of the whole. Therefore, for a radical number, add to the 5312 the number 640, which is to 1245 very nearly as 4^3 to 5^3. This gives 5952. The 64th of this is 93, which corresponds to a bar of one inch square and seven feet long. Therefore 93×7 will be the reciprocal corresponding to a bar of one foot. This is 651. Take from this the present empirical correction, which is $\frac{b\,40}{b\,4}$, or 10, and there remains 641 for the strength of the bar. This gives us for a general rule $p=651\frac{b\,d^2}{l}-10\,b\,d^2$.

Example. Required the weight necessary to break an oak beam eight inches square and 20 feet between the props, $p=651\times\frac{8\times 8^2}{20}-10\times 8\times 8^2$. This is 11545, whereas the experiment gives 11487. The error is very small indeed. The rule is most deficient in comparison with the five-inch bars, which we have already said appear stronger than the rest.

The following process is easily remembered by such as are not algebraists.

Multiply the breadth in inches twice by the depth, and call this product f. Multiply f by 651, and divide by the length in feet. From the quotient take 10 times f. The remainder is the number of pounds which will break the beam.

We are not sufficiently sensible of our principles to be confident that the correction $10\,f$ should be in the proportion of the section, although we think it most probable. It is quite empirical, founded on Buffon's experiments. Therefore the safe way of using this rule is to suppose the beam square, by increasing or diminishing its breadth till equal to the depth. Then find the strength by this rule, and diminish or increase it for the change which has been made in its breadth. Thus, there can be no doubt that the strength of the beam given as an example is double of that of a beam of the same depth and half the breadth.

The reader cannot but observe that all this calculation relates to the very greatest weight which a beam will bear for a very few minutes. Mr Buffon uniformly found

found that two-thirds of this weight ſenſibly impaired its ſtrength, and frequently broke it at the end of two or three months. One-half of this weight brought the beam to a certain bend, which did not increaſe after the firſt minute or two, and may be borne by the beam for any length of time. But the beam contracted a bend, of which it did not recover any conſiderable portion. One-third ſeemed to have no permanent effect on the beam; but it recovered its rectilineal ſhape completely, even after having been loaded ſeveral months, provided that the timber was ſeaſoned when firſt loaded; that is to ſay, one-third of the weight which would quickly break a ſeaſoned beam, or one-fourth of what would break one juſt felled, may lie on it for ever without giving the beam a ſett.

We have no detail of experiments on the ſtrength of other kinds of timber: only Mr Buffon ſays, that fir has about $\frac{6}{10}$ths of the ſtrength of oak; Mr Parent makes it $\frac{1}{1}\frac{0}{1}$ths; Emerſon, $\frac{2}{3}$ds, &c.

We have been thus minute in our examination of the mechaniſm of this tranſverſe ſtrain, becauſe it is the greateſt to which the parts of our machines are expoſed. We wiſh to impreſs on the minds of artiſts the neceſſity of avoiding this as much as poſſible. They are improving in this reſpect, as may be ſeen by comparing the centres on which ſtone arches of great ſpan are now turned with thoſe of former times. They were formerly a load of mere joiſts reſting on a multitude of poſts, which obſtructed the navigation, and were frequently loſing their ſhape by ſome of the poſts ſinking into the ground. Now they are more generally truſſes, where the beams abutt on each other, and are relieved from tranſverſe ſtrains. But many performances of eminent artiſts are ſtill very injudiciouſly expoſed to croſs ſtrains. We may inſtance one which is conſidered as a fine work, viz. the bridge at Walton on Thames. Here every beam of the great arch is a joiſt, and it hangs together by framing. The fineſt piece of carpentry that we have ſeen is the centre employed in turning the arches of the bridge at Orleans, deſcribed by Perronet. In the whole there is not one croſs ſtrain. The beam, too, of Hornblower's ſteam-engine, deſcribed in that article, is very ſcientifically conſtructed.

118
Strain produced by twiſting.

IV. The laſt ſpecies of ſtrain which we are to examine is that produced by twiſting. This takes place in all axles which connect the working parts of machines.

119
The reſiſtance muſt be proportional to the number of particles.

Although we cannot pretend to have a very diſtinct conception of that modification of the coheſion of a body by which it reſiſts this kind of ſtrain, we can have no doubt that, when all the particles act alike, the reſiſtance muſt be proportional to the number. Therefore if we ſuppoſe the two parts ABCD, ABFE (fig. 28.), of the body EFCD to be of inſuperable ſtrength, but cohering more weakly in the common ſurface AB, and that one part ABCD is puſhed laterally in the direction AB, there can be no doubt that it will yield only there, and that the reſiſtance will be proportional to the ſurface.

Fig. 28.

In like manner, we can conceive a thin cylindrical tube, of which KAH (fig. 29) is the ſection, as cohering more weakly in that ſection than anywhere elſe. Suppoſe it to be graſped in both hands, and the two parts twiſted round the axis in oppoſite directions, as we would twiſt the two joints of a flute, it is plain that it will firſt fail in this ſection, which is the circumference of a circle, and the particles of the two parts which are contiguous to this circumference will be drawn from each other laterally. The total reſiſtance will be as the number of equally reſiſting particles, that is, as the circumference (for the tube being ſuppoſed very thin, there can be no ſenſible difference between the dilatation of the external and internal particles). We can now ſuppoſe another tube within this, and a third within the ſecond, and ſo on till we reach the centre. If the particles of each ring exerted the ſame force (by ſuffering the ſame dilatation in the direction of the circumference), the reſiſtance of each ring of the ſection would be as its circumference and its breadth (ſuppoſed indefinitely ſmall, and the whole reſiſtance would be as the ſurface; and this would repreſent the reſiſtance of a ſolid cylinder. But when a cylinder is twiſted in this manner by an external force applied to its circumference, the external parts will ſuffer a greater circular extenſion than the internal; and it appears that this extenſion (like the extenſion of a beam ſtrained tranſverſely) will be proportional to the diſtance of the particles from the axis. We cannot ſay that this is demonſtrable, but we can aſſign no proportion that is more probable. This being the caſe, the forces ſimultaneouſly exerted by each particle will be as its diſtance from the axis. Therefore the whole force exerted by each ring will be as the ſquare of its radius, and the accumulated force actually exerted will be as the cube of the radius; that is, the accumulated force exerted by the whole cylinder, whoſe radius is CA, is to the accumulated force exerted *at the ſame time* by the part whoſe radius is CE, as CA^3 to CE^3.

Fig. 29.

The whole coheſion now exerted is juſt two-thirds of what it would be if all the particles were exerting the ſame attractive forces which are juſt now exerted by the particles in the external circumference. This is plain to any perſon in the leaſt familiar with the fluxionary calculus. But ſuch as are not may eaſily ſee it in this way.

Let the rectangle AC ca be ſet upright on the ſurface of the circle along the line CA, and revolve round the axis Cc. It will generate a cylinder whoſe height is Cc or Aa, and having the circle KAH for its baſe. If the diagonal Ca be ſuppoſed alſo to revolve, it is plain that the triangle cCa will generate a cone of the ſame height, and having for its baſe the circle deſcribed by the revolution of ca, and the point C for its apex. The cylindrical ſurface generated by Aa will expreſs the whole coheſion exerted by the circumference AHK, and the cylindrical ſurface generated by Ee will repreſent the coheſion exerted by the circumference ELM, and the ſolid generated by the triangle CAa will repreſent the coheſion exerted by the whole circle AHK, and the cylinder generated by the rectangle ACca will repreſent the coheſion exerted by the ſame ſurface if each particle had ſuffered the extenſion Aa.

Now it is plain, in the firſt place, that the ſolid generated by the triangle eEC is to that generated by aAC as EC^3 to AC^3. In the next place, the ſolid generated by aAC is two-thirds of the cylinder, becauſe the cone generated by cCa is one-third of it.

We may now ſuppoſe the cylinder twiſted till the particles in the external circumference loſe their coheſion. There can be no doubt that it will now be wrenched aſunder, all the inner circles yielding in ſucceſſion. Thus we obtain one uſeful information, viz. that a body of homogeneous texture reſiſts a *ſimple twiſt* with two-thirds

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thirds of the force with which it resists an attempt to force one part laterally from the other, or with one-third part of the force which will cut it asunder by a square-edged tool. For to drive a square-edged tool through a piece of lead, for instance, is the same as forcing a piece of the lead as thick as the tool laterally away from the two pieces on each side of the tool. Experiments of this kind do not seem difficult, and they would give us very useful information.

120 With what force a body of a homogeneous texture resists a simple twist.

121 The forces exerted in breaking two cylinders are as the squares of the diameters.

When two cylinders AHK and BNO are wrenched asunder, we must conclude that the external particles of each are just put beyond their limits of cohesion, are equally extended, and are exerting equal forces. Hence it follows, that in the instant of fracture the sum total of the forces actually exerted are as the squares of the diameters.

For drawing the diagonal C e, it is plain that E e, $=$ A a, expresses the distension of the circumference ELM, and that the solid generated by the triangle CE e expresses the cohesion exerted by the surface of the circle ELM, when the particles in the circumference suffer the extension E e equal to A a. Now the solids generated by CA a and CE e being respectively two-thirds of the corresponding cylinders, are as the squares of the diameters.

122 Relative strength of the section to the external force employed to break it.

Having thus ascertained the real strength of the section, and its relation to its absolute lateral strength, let us examine its strength relative to the external force employed to break it. This examination is very simple in the case under consideration. The straining force must act by some lever, and the cohesion must oppose it by acting on some other lever. The centre of the section may be the neutral point, whose position is not disturbed.

Let F be the force exerted laterally by an exterior particle. Let a be the radius of the cylinder, and x the indeterminate distance of any circumference, and $\dot{x}$ the indefinitely small interval between the concentric arches; that is, let $\dot{x}$ be the breath of a ring and x its radius. The forces being as the extensions, and the extensions as the distances from the axis, the cohesion actually exerted at any part of any ring will be $f\frac{x\dot{x}}{a}$. The force exerted by the whole ring (being as the circumference or as the radius) will be $f\frac{x^2\dot{x}}{a}$. The momentum of cohesion of a ring, being as the force multiplied by its lever, will be $f\frac{x^3\dot{x}}{a}$. The accumulated momentum will be the sum or fluent of $f\frac{x^3\dot{x}}{a}$; that is, when $x=a$, it will be $\frac{1}{4}f\frac{a^4}{a}, = \frac{1}{4}fa^3$.

123 The resistance of the axle is as the cube of its diameter.

Hence we learn that the strength of an axle, by which it resists being wrenched asunder by a force acting at a given distance from the axis, is as the cube of its diameter.

But farther, $\frac{1}{4}fa^3$ is $=fa^2\times\frac{1}{4}a$. Now fa^2 represents the full lateral cohesion of the section. The momentum therefore is the same as if the full lateral cohesion were accumulated at a point distant from the axis by one-fourth of the radius or one-eighth of the diameter of the cylinder.

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Therefore let F be the number of pounds which measures the lateral cohesion of a circular inch, d the diameter of the cylinder in inches, and l the length of the lever by which the straining force p is supposed to act, we shall have $F\times\frac{1}{8}d^3=pl$, and $F\frac{d^3}{8l}=p$.

We see in general that the strength of an axle, by which it resists being wrenched asunder by twisting, is as the cube of its diameter.

We see also that the internal parts are not acting so powerfully as the external. If a hole be bored out of the axle of half its diameter, the strength is diminished only one-eighth, while the quantity of matter is diminished one-fourth. Therefore hollow axles are stronger than solid ones containing the same quantity of matter. Thus let the diameter be 5 and that of the hollow 4: then the diameter of another solid cylinder having the same quantity of matter with the tube is 3. The strength of the solid cylinder of the diameter 5 may be expressed by 5^3 or 125. Of this the internal part (of the diameter 4) exerts 64; therefore the strength of the tube is $125-64, = 61$. But the strength of the solid axle of the same quantity of matter and diameter 3 is 3^3, or 27, which is not half of that of the tube.

114 Hollow axles more proper than solid ones,

125 and now generally used.

Engineers, therefore, have of late introduced this improvement in their machines, and the axles of cast iron are all made hollow when their size will admit it. They have the additional advantage of being much stiffer, and of affording much better fixture for the flanches, which are used for connecting them with the wheels or levers by which they are turned and strained. The superiority of strength of hollow tubes over solid cylinders is much greater in this kind of strain than in the former or transverse. In this last case the strength of this tube would be to that of the solid cylinder of equal weight as 61 to 32 and a half nearly.

The apparatus which we mentioned on a former occasion for trying the lateral strength of a square inch of solid matter, enabled us to try this theory of twist with all desirable accuracy. The bar which hung down from the pin in the former trials was now placed in a horizontal position, and loaded with a weight at the extremity. Thus it acted as a powerful lever, and enabled us to wrench asunder specimens of the strongest materials. We found the results perfectly conformable to the theory, in as far as it determined the proportional strength of different sizes and forms: but we found the ratio of the resistance to twisting to the simple lateral resistance considerably different; and it was some time before we discovered the cause.

126 The ratio of resistance to twisting to the simple lateral resistance appears different.

We had here taken the simplest view that is possible of the action of cohesion in resisting a twist. It is frequently exerted in a very different way. When, for instance, an iron axle is joined to a wooden one by being driven into one end of it, the extensions of the different circles of particles are in a very different proportion. A little consideration will show that the particles in immediate contact with the iron axle are in a state of violent extension; so are the particles of the exterior surface of the wooden part, and the intermediate parts are less strained. It is almost impossible to assign the exact proportion of the cohesive forces exerted in the different parts.

Strength of Materials.

parts. Numberlefs cafes can be pointed out where parts of the axle are in a ftate of compreffion, and where it is ftill more difficult to determine the ftate of the other particles. We muft content ourfelves with the deductions made from this fimple cafe, which is fortunately the moft common. In the experiments juft now mentioned the centre of the circle is by no means the neutral point, and it is very difficult to afcertain its place: but when this confideration occurred to us, we eafily freed the experiments from this uncertainty, by extending the lever to both fides, and by means of a pulley applied equal force to each arm, acting in oppofite directions. Thus the centre became the neutral point, and the refiftance to twift was found to be two-thirds of the fimple lateral ftrength.

127 But when the experiment was altered, it was exactly the fame.

128 Experiments on chalk, clay, and wax, fatisfactory; but thofe on timber irregular.

We beg leave to mention here that our fuccefs in thefe experiments encouraged us to extend them much farther. We hoped by thefe means to difcover the abfolute cohefion of many fubftances, which would have required an enormous apparatus and a moft unmanageable force to tear them afunder directly. But we could reafon with confidence from the refiftance to twift (which we could eafily meafure), provided that we could afcertain the proportion of the direct and the lateral ftrengths. Our experiments on chalk, finely prepared clay, and white bees-wax (of one melting and one temperature), were very confiftent and fatisfactory. But we have hitherto found great irregularities in this proportion in bodies of a fibrous texture like timber. Thefe are the moft important cafes, and we ftill hope to be able to accomplifh our project, and to give the public fome valuable information. This being our fole object, it was our duty to mention the method which promifes fuccefs, and thus excite others to the tafk; and it will be no mortification to us to be deprived of the honour of being the firft who thus adds to the ftock of experimental knowledge.

When the matter of the axle is of the moft fimple texture, fuch as that of metals, we do not conceive that the length of the axle has any influence on the fracture. It is otherwife if it be of a fibrous texture like timber: the fibres are bent before breaking, being twifted into fpirals like a cork-fcrew. The length of the axle has fomewhat of the influence of a lever in this cafe, and it is eafier wrenched afunder if long. Accordingly we have found it fo; but we have not been able to reduce this influence to calculation.

129 Concluding remarks.

Our readers are requefted to accept of thefe endeavours to communicate information on this important and difficult fubject. We are duly fenfible of their imperfection, but flatter ourfelves that we have in many inftances pointed out the method which muft be purfued for improving our knowledge on this fubject; and we have given the Englifh reader a more copious lift of experiments on the ftrength of materials than he will meet with in our language. Many ufeful deductions might be made from thefe premifes refpecting the manner of difpofing and combining the ftrength of materials in our ftructures. The beft form of joints, mortifes, tenons, fcarphs; the rules for joggling, tabling, faying, fifhing, &c. practifed in the delicate art of maft-making, are all founded on this doctrine: but the difcuffion of thefe would be equivalent to writing a complete treatife of carpentry. We hope that this will be executed by fome intelligent mechanician, for there is nothing in our language on this fubject but what is almoft contemptible; yet there is no mechanic art that is more fufceptible of fcientific treatment. Such a treatife, if well executed, could not fail of being well received by the public in this age of mechanical improvement.

Strengtheners ‖ Stroking.

STRENGTHENERS, or CORROBORANTS, fuch medicines as are fuppofed to add to the firmnefs of the folids. See MATERIA MEDICA *Index*.

STRETCHING, in *Navigation*, is generally underftood to imply the progreffion of a fhip under a great furface of fail, when clofe-hauled. The difference between this term and *ftanding*, confifts apparently in the quantity of fail; which in the latter may be very moderate; but ftretching generally fignifies excefs; as, we faw the enemy at daybreak ftretching to the fouthward under a croud of fail, &c. *Falconer*.

STRETTO, in Italian mufic, is fometimes ufed to fignify that the meafure is to be fhort and concife, and confequently quick. In this fenfe it ftands oppofed to LARGO.

STRIATED LEAF, among botanifts, one that has a number of longitudinal furrows on its furface.

STRIKE, a meafure of capacity, containing four bufhels. Alfo an inftrument ufed in meafuring corn.

STRIX, the OWL; a genus of birds belonging to the order of accipitres. See ORNITHOLOGY *Index*.

The *bubo*, or great-eared owl inhabits inacceffible rocks and defert places, and preys on hares and feathered game. Its appearance in cities was deemed an unlucky omen; Rome itfelf once underwent a luftration becaufe one of them ftrayed into the capitol. The ancients had them in the utmoft abhorrence; and thought them, like the fcreech-owls, the meffengers of death. Pliny ftyles it *bubo funebris*, and *noctis monftrum*.

Solaque culminibus ferali *carmine* bubo
Sæpe queri et longas in fletum ducere voces. VIRGIL.

Perch'd on the roof, the bird of night complains,
In lengthen'd fhrieks and dire funereal ftrains.

STROBILUS, in *Botany*, a pericarp formed from an amentum by the hardening of the fcales.

STROKING, or rubbing gently with the hand, a method which has been employed by fome perfons for curing difeafes.

Mr Greatrakes or Greatrix, the famous Irifh ftroker, is faid to have performed many wonderful cures. He gives the following account of his difcovery of this art, and of the fuccefs with which he practifed it. "About 1662 I had an impulfe (fays he), or a ftrange perfuafion in my own mind (of which I am not able to give any rational account to another), which did very frequently fuggeft to me, that there was beftowed on me the gift of curing the king's evil; which, for the extraordinarinefs of it, I thought fit to conceal for fome time; but at length I communicated this to my wife, and told her, that I did verily believe that God had given me the bleffing of curing the king's evil; for whether I were in private or public, fleeping or waking, ftill I had the fame impulfe. But her reply to me was, that fhe conceived this was a ftrange imagination; yet, to prove the contrary, a few days after there was one William Mather of Salterbridge in the parifh of Lifmore, who brought his fon William to my houfe, defiring my wife to cure him, who was a perfon ready to afford her charity to her neighbours, according to her fmall fkill in chirurgery.

See *Brief Account of Mr Valentine Greatrakes*, Lond. 1666, 4to.

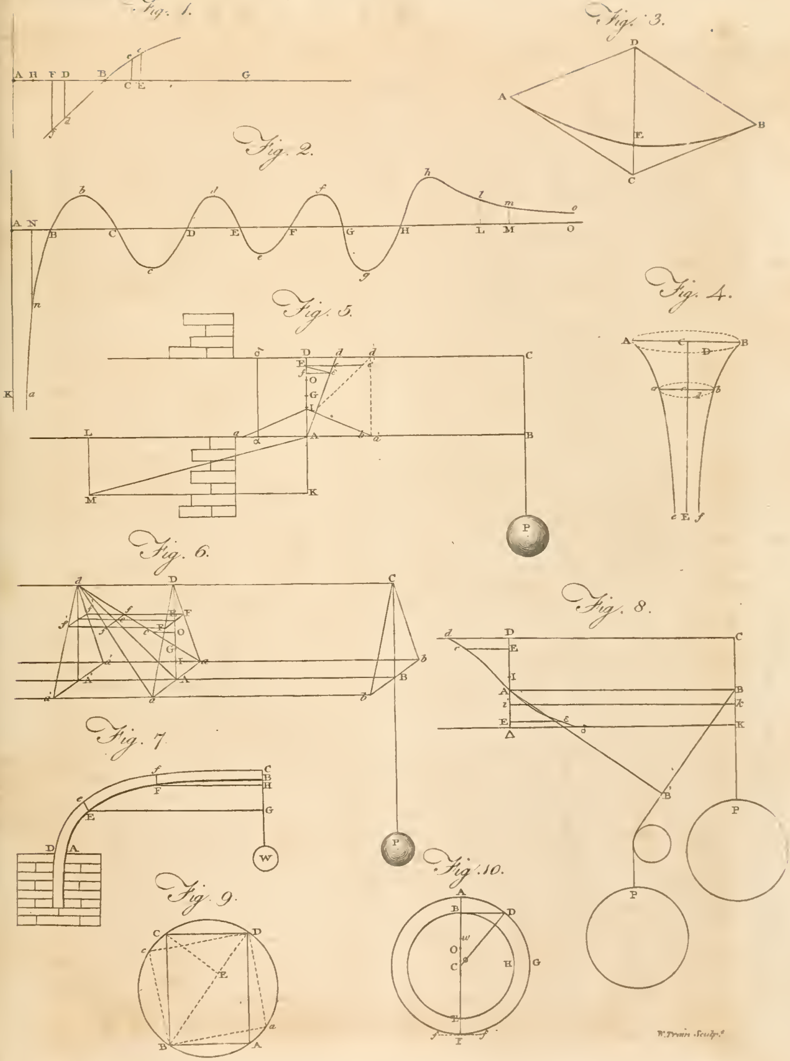
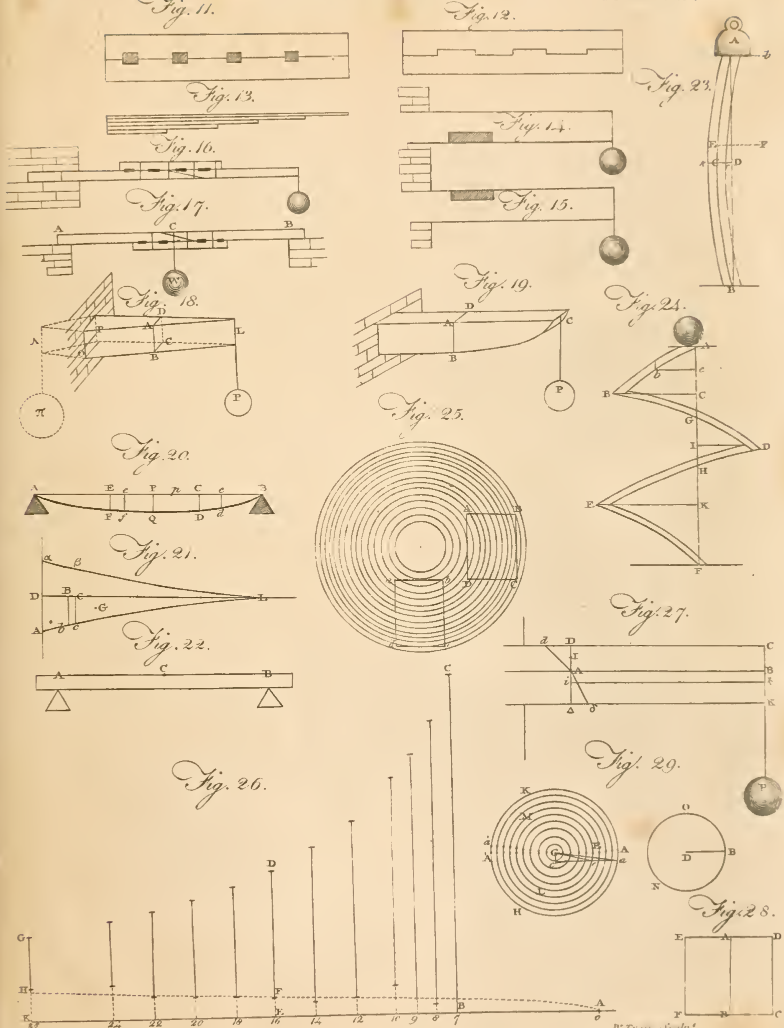


Fig. 1.
Fig. 2.
Fig. 3.
Fig. 4.
Fig. 5.
Fig. 6.
Fig. 7.
Fig. 8.
Fig. 9.
Fig. 10.

STRENGTH of MATERIALS. Plate DXII.



chirurgery. On which my wife told me, there was one that had the king's evil very grievoufly in the eyes, cheek, and throat; whereupon I told her, that fhe fhould now fee whether this was a bare fancy or imagination, as fhe thought it, or the dictates of God's Spirit on my heart. Then I laid my hands on the places affected, and prayed to God for Jefus fake to heal him; and bid the parent two or three days afterwards to bring the child to me again, which accordingly he did; and I then faw the eye was almoft quite whole; and the node, which was almoft as big as a pullet's egg, was fuppurated; and the throat ftrangely amended; and, to be brief (to God's glory I fpeak it) within a month difcharged itfelf quite, and was perfectly healed, and fo continues, God be praifed."

Then there came to him one Margaret Mackfhane of Ballinecly, in the parifh of Lifmore, who had been afflicted with the evil above feven years, in a much more violent degree; and foon after, his fame increafing, he cured the fame difeafe in many other perfons for three years. He did not meddle all this time with any other diftemper; till about the end of thefe three years, the ague growing epidemical, he found, as formerly, that there was beftowed on him the gift of curing that difeafe. He cured Colonel Phaire, of Cahirmony in the county of Corke, of an ague, and afterwards many other perfons of different diftempers, by ftroking; fo that his name was wonderfully cried up, as if fome divine perfon had been fent from above. January 1665-6, he came over to England, at the requeft of the earl of Orrery; in order to cure the lady of the lord-vifcount Conway, of Ragley in Warwickfhire, who had for many years laboured under a moft violent headache. He ftaid at Ragley three weeks or a month; and though he failed in his endeavours to relieve that lady, he cured vaft numbers of people in thofe parts and at Worcefter.

Though we are no friends to the marvellous, nor believe it poffible that either the king's evil or ague can be cured by ftroking or friction of any kind, whether gentle or fevere, we have no hefitation to acknowledge that many cures might be performed by Mr Greatrakes. Every reflecting perfon who reads the foregoing account which he gives of himfelf will fee that he was an enthufiaft, and believed himfelf guided by a particular revelation; and fuch is the credulity of mankind, that his pretenfions were readily admitted, and men crouded with eagernefs to be relieved of their difeafes. But it is well known to phyficians, that in many cafes the imagination has accomplifhed cures as wonderful as the force of medicine. It is owing chiefly to the influence of imagination that we have fo many accounts from people of veracity of the wonderful effects of quack medicines. We are perfectly affured that thefe medicines, by their natural operation, can never produce the effects afcribed to them; for there is no kind of proportion between the medicine and the effect produced, and often no connection between the medicine and the difeafe.

STROMATEUS, a genus of fifhes belonging to the order of apodes. See ICHTHYOLOGY *Index*.

STROMBOLI, the moft northern of the Lipari iflands. It is a volcano, which conftantly difcharges much fire and fmoke. It rifes in a conical form above the furface of the fea. On the eaft fide it has three or four little craters ranged near each other, not at the fummit, but on the declivity, nearly at two-thirds of its height. But as the furface of the volcano is very rugged and interfected with hollow ways, it may be naturally concluded, that at the time of fome great eruption, the fummit and a part of this fide fell in, as muft have happened alfo to Vefuvius; confequently, the common chimney is at this day on the declivity, although always in the centre of the whole bafe. It is inhabited notwithftanding its fires; but care is taken to avoid the proximity of the crater, which is yet much to be feared. "I was affured (fays M. de Luc) by an Englifhman, who, like me, had the curiofity to vifit thefe ifles, that the fine weather having invited him and his company to land at Stromboli, they afcended a volcano, whofe craters at that time threw out nothing; but that while they were attentively viewing them, unapprehenfive of any danger, they were fuddenly faluted by fuch a furious difcharge, as to be obliged to retreat with precipitation, and not without one of the company being wounded by a piece of fcoria." Of all the volcanoes recorded in hiftory, Stromboli feems to be the only one that burns without ceafing. Etna and Vefuvius often lie quiet for many months, and even years, without the leaft appearance of fire; but Stromboli is ever at work, and for ages paft has been looked upon as the great lighthoufe of thefe feas. E. Long. 15. 45. N. Lat. 30. 0.

STROMBUS, a genus of fhell-fifh. See CONCHOLOGY *Index*.

STRONGOLI, a town of the kingdom of Naples, with a bifhop's fee. It is fituated on a rugged mountain, is about three miles from the fea, and feven north from St Severino. It is fuppofed to be the ancient *Petelia*, which made a confpicuous figure in the fecond Punic war by its obftinate refiftance againft Hannibal. Near its walls Marcellus the rival of Hannibal was flain in a fkirmifh. E. Long. 17. 26. N. Lat. 39. 20.

STRONTITES, or STRONTIAN EARTH, fo called from having been difcovered at Strontian in Scotland. See CHEMISTRY *Index*.

STROPHE, in ancient poetry, a certain number of verfes, including a perfect fenfe, and making the firft part of an ode. See POETRY, N° 130.

STRUMÆ, fcrophulous tumours arifing on the neck and throat, conftituting what is commonly called the *king's evil*. See MEDICINE *Index*.

STRUMPFIA, a genus of plants belonging to the clafs fyngenefia. See BOTANY *Index*.

STRUTHIO, a genus of birds belonging to the order of grallæ. See ORNITHOLOGY *Index*.

STRUTHIOLA, a genus of plants belonging to the clafs of tetrandria. See BOTANY *Index*.

STRYCHNOS, a genus of plants belonging to the clafs pentandria, and in the natural fyftem ranging under the 28th order, *luridæ*. See BOTANY *Index*.

STRYMON, in *Ancient Geography*, formerly *Conozus*; a river conftituting the ancient limits of Macedonia and Thrace; rifing in Mount Scombrus (Ariftotle). Authors differ as to the modern name of this river.

STRYPE, JOHN, was defcended from a German family, born at London, and educated at Cambridge. He was vicar of Low Layton in Effex, and diftinguifhed himfelf by his compilations of Lives and Memoirs; in which, as Dr Birch remarks, his fidelity and induftry will always give a value to his writings, however deftitute they may be of the graces of ſtyle. He died in 1737, after having enjoyed his vicarage near 68 years.

STUART, Dr Gilbert, was born at Edinburgh in the year 1742. His father Mr George Stuart was profeſſor of humanity in the univerſity, and a man of conſiderable eminence for his claſſical taſte and literature. For theſe accompliſhments he was probably indebted in no ſmall degree to his relation the celebrated Ruddiman, with whom both he and his ſon converſed familiarly, though they afterwards united to injure his fame.

Gilbert having finiſhed his claſſical and philoſophical ſtudies in the grammar-ſchool and univerſity, applied himſelf to juriſprudence, without following, or probably intending to follow, the profeſſion of the law. For that profeſſion he has been repreſented as unqualified by indolence; by a paſſion which at a very early period of life he diſplayed for general literature; or by boundleſs diſſipation:—and all theſe circumſtances may have contributed to make him relinquiſh purſuits in which he could hope to ſucceed only by patient perſeverance and ſtrict decorum of manners. That he did not waſte his youth in idleneſs, is, however, evident from An Hiſtorical Diſſertation concerning the Antiquity of the Britiſh Conſtitution, which he publiſhed before he had completed his twenty-ſecond year, and which had ſo much merit as to induce the univerſity of Edinburgh to confer upon the author, though ſo young a man, the degree of LL.D.

After a ſtudious interval of ſome years, he produced a valuable work, under the title of A View of Society in Europe, in its Progreſs from Rudeneſs to Refinement; or, Inquiries concerning the Hiſtory of Laws, Government, and Manners. He had read and meditated with patience on the moſt important monuments of the middle ages; and in this volume (which ſpeedily reached a ſecond edition) he aimed chiefly at the praiſe of originality and invention; and diſcovered an induſtry that is ſeldom connected with ability and diſcernment. About the time of the publication of the firſt edition of this performance, having turned his thoughts to an academical life, he aſked for the profeſſorſhip of public law in the univerſity of Edinburgh. According to his own account he had been promiſed that place by the miniſter, but had the mortification to ſee the profeſſorſhip beſtowed on another, and all his hopes blaſted by the influence of Dr Robertſon, whom he repreſented as under obligations to him.

To the writer of this article, who was a ſtranger to theſe rival candidates for hiſtorical fame, this part of the ſtory ſeems very incredible; as it is not eaſy to conceive how it ever could be in the power of Dr Stuart to render to the learned Principal any eſſential ſervice. It was believed indeed by the earl of Buchan, and by others, who obſerved that the illiberal jealouſy not unfrequent in the world of letters, was probably the ſource of this oppoſition; which entirely broke the intimacy of two perſons who, before that time, were underſtood to be on the moſt friendly footing with each other. Ingratitude, however, is as likely to have been the vice of Dr Stuart as of Dr Robertſon; for we have been told by a writer *, who, at leaſt in one inſtance, has completely proved what he affirms, that "ſuch was Gilbert Stuart's laxity of principle as a man, that he conſidered ingratitude as one of the moſt venial ſins; ſuch was his conceit as a writer, that he regarded no one's merits but his own; ſuch were his diſappointments, both as a writer and a man, that he allowed his peeviſhneſs to ſour into malice, and indulged his malevolence till it ſettled in corruption."

* *Chalmers in his Life of Ruddiman.*

Soon after this diſappointment, Dr Stuart went to London, where he became from 1768 to 1774 one of the writers of the Monthly Review. In 1772 Dr Adam, rector of the high-ſchool at Edinburgh, publiſhed a Latin Grammar, which he intended as an improvement of the famous Ruddiman's. Stuart attacked him in a pamphlet under the name of *Buſhby*, and treated him with much ſeverity. In doing this, he was probably actuated more by ſome perſonal diſlike of Dr Adam than by regard for the memory of his learned relation; for on other occaſions he ſhowed ſufficiently that he had no regard to Ruddiman's honour as a grammarian, editor, or critic.

In 1774 he returned to his native city, and began the Edinburgh Magazine and Review, in which he diſcuſſed the liberty and conſtitution of England, and diſtinguiſhed himſelf by an inquiry into the character of John Knox the reformer, whoſe principles he reprobated in the ſevereſt terms. About this time he reviſed and publiſhed Sullivan's Lectures on the Conſtitution of England. Soon after he turned his thoughts to the hiſtory of Scotland, and publiſhed Obſervations concerning its Public Law and Conſtitutional Hiſtory; in which he examined with a critical care the preliminary book to Dr Robertſon's Hiſtory. His next work was The Hiſtory of the Reformation; a book which deſerves praiſe for the eaſy dignity of the narrative, and for ſtrict impartiality. His laſt great work, The Hiſtory of Scotland from the Eſtabliſhment of the Reformation to the Death of Queen Mary, which appeared in 1782, has been very generally read and admired. His purpoſe was to vindicate the character of the injured queen, and expoſe the weakneſs of the arguments by which Dr Robertſon had endeavoured to prove her guilty: but though the ſtyle of this work is his own, it contains very little matter which was not furniſhed by Goodall and Tytler; and it is with the arms which theſe two writers put into his hands that Dr Stuart attacked his great antagoniſt.

In 1782 he once more viſited London, and engaged in the Political Herald and Engliſh Review; but the jaundice and dropſy increaſing on him, he returned by ſea to his native country, where he died in the houſe of his father on the 13th of Auguſt 1786.

In his perſon Dr Stuart was about the middle ſize and juſtly proportioned. His countenance was modeſt and expreſſive, ſometimes glowing with ſentiments of friendſhip, of which he was truly ſuſceptible, and at others darting that ſatire and indignation at folly and vice which appear in ſome of his writings. He was a boon companion; and, with a conſtitution that might have ſtood the ſhock of ages, he fell a premature martyr to intemperance. His talents were certainly great, and his writings are uſeful; but he ſeems to have been influenced more by paſſion than prejudice, and in his character there was not much to be imitated.

STUCCO, in building, a compoſition of white marble pulveriſed, and mixed with plaſter of lime; and the whole being ſifted and wrought up with water, is to be uſed like common plaſter: this is called by Pliny *marmoratum opus*, and *albarium opus*.

A patent has been granted to Mr B. Higgins for inventing a new kind of ſtucco, or water-cement, more firm and durable than any heretofore. Its compoſition, as extracted from the ſpecification ſigned by himſelf, is as follows: "Drift-ſand, or quarry (A) ſand, which conſiſts chiefly of hard quartoſe flat-faced grains with ſharp angles; which is the freeſt, or may be moſt eaſily freed by waſhing, from clay, ſalts, and calcareous, gypſeous, or other grains leſs hard and durable than quartz; which contains the ſmalleſt quantity of pyrites or heavy metallic matter inſeparable by waſhing; and which ſuffers the ſmalleſt diminution of its bulk in waſhing in the following manner—is to be preferred before any other. And where a coarſe and a fine ſand of this kind, and correſponding in the ſize of their grains with the coarſe and fine ſands hereafter deſcribed, cannot be eaſily procured, let ſuch ſand of the foregoing quality be choſen as may be ſorted and cleanſed in the following manner:

"Let the ſand be ſifted in ſtreaming clear water, through a ſieve which ſhall give paſſage to all ſuch grains as do not exceed one-ſixteenth of an inch in diameter; and let the ſtream of water and the ſifting be regulated ſo that all the ſand, which is much finer than the Lynn-ſand commonly uſed in the London glaſs-houſes, together with clay and every other matter ſpecifically lighter than ſand, may be waſhed away with the ſtream, whilſt the purer and coarſer ſand, which paſſes through the ſieve, ſubſides in a convenient receptacle, and whilſt the coarſe rubbiſh and rubble remain on the ſieve to be rejected.

"Let the ſand which thus ſubſides in the receptacle be waſhed in clean ſtreaming water through a finer ſieve, ſo as to be further cleanſed and ſorted into two parcels; a coarſer, which will remain in the ſieve which is to give paſſage to ſuch grains of ſand only as are leſs than one-thirtieth of an inch in diameter, and which is to be ſaved apart under the name of *coarſe ſand*: and a finer, which will paſs through the ſieve and ſubſide in the water, and which is to be ſaved apart under the name of *fine ſand*.—Let the coarſe and the fine ſand be dried ſeparately, either in the ſun or on a clean iron-plate, ſet on a convenient ſurface, in the manner of a ſand-heat (B).

"Let lime be choſen (C) which is ſtone-lime, which heats the moſt in ſlaking, and ſlakes the quickeſt when duly watered; which is the freſheſt made and cloſeſt kept; which diſſolves in diſtilled vinegar with the leaſt effervescence, and leaves the ſmalleſt reſidue inſoluble, and in this reſidue the ſmalleſt quantity of clay, gypſum, or martial matter.

"Let the lime choſen according to theſe important rules be put in a braſs-wired ſieve to the quantity of 14 pounds. Let the ſieve be finer than either of the foregoing; the finer, the better it will be: let the lime be ſlaked (D) by plunging it in a butt filled with ſoft water, and raiſing it out quickly and ſuffering it to heat and fume, and by repeating this plunging and raiſing alternately, and agitating the lime, until it be made to paſs through the ſieve into the water; and let the part of the lime which does not eaſily paſs through the ſieve be rejected: and let freſh portions of the lime be thus uſed, until as many (E) ounces of lime have paſſed through the ſieve as there are quarts of water in the butt. Let the water thus impregnated ſtand in the butt cloſely covered (F) until it becomes clear; and through wooden (G) cocks placed at different heights in the butt), let the clear liquor be drawn off as faſt (H) and as

(A) "This is commonly called *pit-ſand*.

(B) "The ſand ought to be ſtirred up continually until it is dried, and is then to be taken off; for otherwiſe the evaporation will be very ſlow, and the ſand which lies next the iron plate, by being overheated, will be diſcoloured.

(C) "The preference given to ſtone-lime is founded on the preſent practice in the burning of lime, and on the cloſer texture of it, which prevents it from being ſo ſoon injured by expoſure to the air as the more ſpongy chalk-lime is; not on the popular notion that ſtone-lime has ſomething in it whereby it excels the beſt chalk in the cementing properties. The gypſum contained in lime-ſtone remains unaltered, or very little altered, in the lime, after the burning; but it is not to be expected that clay or martial matter ſhould be found in their native ſtate in well-burned lime; for they concrete or vitrify with a part of the calcareous earth, and conſtitute the hard grains or lumps which remain undiſſolved in weak acids, or are ſeparable from the ſlaked lime by ſifting it immediately through a ſieve.

(D) "This method of impregnating the water with lime is not the only one which may be adopted. It is, however, preferred before others, becauſe the water clears the ſooner in conſequence of its being warmed by the ſlaking lime; and the gypſeous part of the lime does not diffuſe itſelf in the water ſo freely in this way as it does when the lime is ſlaked to fine powder in the common method, and is then blended with the water; for the gypſeous part of the lime ſlakes at firſt into grains rather than into fine powder, and will remain on the ſieve after the pure lime has paſſed through, long enough to admit of the intended ſeparation; but when the lime is otherwiſe ſlaked, the gypſeous grains have time to ſlake to a finer powder, and paſſing through the ſieve, diſſolve in the water along with the lime. I have imagined that other advantages attended this method of preparing the lime-water, but I cannot yet ſpeak of them with preciſion.

(E) "If the water contains no more acidulous gas than is uſually found in river or rain water, a fourth part of this quantity of lime, or leſs, will be ſufficient.

(F) "The calcareous cruſt which forms on the ſurface of the water ought not to be broken, for it aſſiſts in excluding the air, and preventing the abſorption of acidulous gas whereby the lime-water is ſpoiled.

(G) "Braſs-cocks are apt to colour a part of the liquor.

(H) "Lime-water cannot be kept many days unimpaired, in any veſſels that are not perfectly air-tight. If the liquor be drawn off before it clears, it will contain whiting, which is injurious; and if it be not inſtantly uſed as low as the lime fubfides, for ufe. This clear liquor I call the *cementing liquor* (I). The freer the water is from faline matter, the better will be the cementing liquor made with it.

"Let 56 pounds of the aforefaid chofen lime be flaked, by gradually fprinkling on it, and efpecially on the unflaked pieces, the cementing liquor, in a clofe (K) clean place. Let the flaked part be immediately (L) fifted through the laft-mentioned fine brafs-wired fieve: Let the lime which paffes be ufed inftantly, or kept in air-tight veffels, and let the part of the lime which does not pafs through the fieve be rejected (M).—This finer richer part of the lime which paffes through the fieve I call *purified lime*.

"Let bone-afh be prepared in the ufual manner, by grinding the whiteft burnt bones, but let it be fifted, to be much finer than the bone-afh commonly fold for making cupels.

"The moft eligible materials for making my cement being thus prepared, take 56 pounds of the coarfe fand and 42 pounds of the fine fand; mix them on a large plank of hard wood placed horizontally; then fpread the fand fo that it may ftand to the height of fix inches, with a flat furface on the plank; wet it with the cementing liquor; and let any fuperfluous quantity of the liquor, which the fand in the condition defcribed cannot retain, flow away off the plank. To the wetteft fand add 14 pounds of the putrefied lime in feveral fucceffive portions, mixing and beating them up together in the mean time with the inftruments generally ufed in making fine mortar: then add 14 pounds of the bone-afh in fucceffive portions, mixing and beating all together. The quicker and the more perfectly thefe materials are mixed and beaten together, and the fooner the cement thus formed is ufed, the better (N) it will be. This I call the *water-cement coarfe-grained*, which is to be applied in building, pointing, plaftering, ftuccoing, or other work, as mortar and ftucco now are; with this difference chiefly, that as this cement is fhorter than mortar or common ftucco, and dries fooner, it ought to be worked expeditioufly in all cafes; and in ftuccoing, it ought to be laid on by fliding the trowel upwards on it; that the materials ufed along with this cement in building, or the ground on which it is to be laid in ftuccoing, ought to be well wetted with the cementing liquor in the inftant of laying on the cement; and that the cementing liquor is to be ufed when it is neceffary to moiften the cement, or when a liquid is required to facilitate the floating of the cement.

"When fuch cement is required to be of a finer texture, take 98 pounds of the fine fand, wet it with the cementing liquor, and mix it with the purified lime and the bone-afh in the quantities and in the manner above defcribed; with this difference only, that 15 pounds of lime, or (O) thereabouts, are to be ufed inftead of 14 pounds, if the greater part of the fand be as fine as Lynn-fand. This I call *water-cement fine-grained*. It is to be ufed in giving the laft coating, or the finifh to any work intended to imitate the finer-grained ftones or ftucco. But it may be applied to all the ufes of the water-cement coarfe-grained, and in the fame manner.

"When for any of the foregoing purpofes of pointing, building, &c. fuch a cement is required much cheaper and coarfer-grained, then much coarfer clean fand than the foregoing coarfe fand, or well-wafhed fine rubble, is to be provided. Of this coarfe fand or rubble take 56 pounds, of the foregoing coarfe fand 28 pounds, and of the fine fand 14 pounds; and after mixing thefe, and wetting them with the cementing liquor in the foregoing manner, add 14 pounds, or fomewhat lefs, of the (P) purified lime, and then 14 pounds or fomewhat lefs

ufed after it is drawn limpid from the butt into open veffels, it will grow turbid again, and depofit the lime changed to whiting by the gas abforbed from the air. The calcareous matter which fubfides in the butt refembles whiting the more nearly as the lime has been more fparingly employed; in the contrary circumftances, it approaches to the nature of lime; and in the intermediate ftate, it is fit for the common compofition of the plafterers for infide ftucco.

(I) "At the time of writing this fpecification, I preferred this term before that of lime-water, on grounds which I had not fufficiently examined.

(K) "The vapour which arifes in the flaking of lime contributes greatly to the flaking of thefe pieces which lie in its way; and an unneceffary wafte of the liquor is prevented, by applying it to the lime heaped in a pit or in a veffel, which may reftrain the iffue of the vapour, and direct it through the mafs. If more of the liquor be ufed than is neceffary to flake the lime, it will create error in weighing the flaked powder, and will prevent a part of it from paffing freely through the fieve. The liquid is therefore to be ufed fparingly, and the lime which has efcaped its action is to be fprinkled apart with frefh liquor.

(L) "When the aggregation of the lumps of lime is thus broken, it is impaired much fooner than it is in the former ftate, becaufe the air more freely pervades it.

(M) "Becaufe it confifts of heterogeneous matter or of ill-burnt lime; which laft will flake and pafs through the fieve, if the lime be not immediately fifted after the flaking, agreeable to the text.

(N) "Thefe proportions are intended for a cement made with fharp fand, for incruftation in expofed fituations, where it is neceffary to guard againft the effects of hot weather and rain. In general, half this quantity of bone-afhes will be found fufficient; and although the incruftation in this latter cafe will not harden deeply fo foon, it will be ultimately ftronger, provided the weather be favourable.

"The injuries which lime and mortar fuftain by expofure to the air, before the cement is finally placed in a quiefcent ftate, are great; and therefore our cement is the worfe for being long beaten, but the better as it is quickly beaten until the mixture is effected, and no longer.

(O) "The quantity of bone-afhes is not to be increafed with that of the lime; but it is to be leffened as the expofure and purpofes of the work will admit.

(P) "Becaufe lefs lime is neceffary, as the fand is coarfer.

lefs of the bone-afh, mixing them together in the manner already defcribed. When my cement is required to be white, white fand, white lime, and the whiteft bone-afh are to be chofen. Gray fand, and gray bone-afh formed of half-burnt bones, are to be chofen to make the cement gray; and any other colour of the cement is obtained, either by choofing coloured fand, or by the admixture of the neceffary quantity of coloured talc in powder, or of coloured, vitreous, or metallic powders, or other durable colouring ingredients commonly ufed in paint.

"To the end that fuch a water-cement as I have defcribed may be made as ufeful as it is poffible in all circumftances; and that no perfon may imagine that my claim and right under thefe letters-patent may be eluded by divers variations, which may be made in the foregoing procefs without producing any notable defect in the cement; and to the end that the principles of this art, as well as the art itfelf, of making my cement, may be gathered from this fpecification and perpetuated to the public; I fhall add the following obfervations:

"This my water-cement, whether the coarfe or fine grained, is applicable in forming artificial ftone, by making alternate layers of the cement and of flint, hard ftone, or brick, in moulds of the figure of the intended ftone, and by expofing the maffes fo formed to the open (Q) air to harden.

"When fuch cement is required for water (R) fences, two-thirds of the prefcribed quantity of bone-afhes are to be omitted; and in the place thereof an equal meafure of powdered terras is to be ufed; and if the fand employed be not of the coarfeft fort, more terras muft be added, fo that the terras fhall be by weight one-fixth part of the weight of the fand.

"When fuch a cement is required of the fineft grain (S) or in a fluid form, fo that it may be applied with a brufh, flint powder, or the powder of any quartofe or hard earthy fubftance, may be ufed in the place of fand; but in a quantity fmaller, as the flint or other powder is finer; fo that the flint-powder, or other fuch powder, fhall not be more than fix times the weight of the lime, nor lefs than four times its weight. The greater the quantity of lime within thefe limits, the more will the cement be liable to crack by quick drying, and *vice verfa*.

"Where fuch fand as I prefer cannot be conveniently procured, or where the fand cannot be conveniently wafhed and forted, that fand which moft refembles the mixture of coarfe and fine fand above prefcribed, may be ufed as I have directed, provided due attention is paid to the quantity of the lime, which is to be greater (T) as the quantity is finer, and *vice verfa*.

"Where fand cannot be eafily procured, any durable ftony body, or baked earth grofsly powdered (U), and forted nearly to the fizes above prefcribed for fand, may be ufed in the place of fand, meafure for meafure, but not weight for weight, unlefs fuch grofs powder be as heavy fpecifically as fand.

"Sand may be cleanfed from every fofter, lighter, and lefs durable matter, and from that part of the fand which is too fine, by various methods preferable (X), in certain circumftances, to that which I have defcribed.

"Water may be found naturally free from fixable gas, felenite, or clay; fuch water may, without any notable inconvenience, be ufed in the place of the cementing liquor; and water approaching this ftate will not require fo much lime as I have ordered to make the cementing liquor; and a cementing liquor fufficiently ufeful may be made by various methods of mixing lime and water in the defcribed proportions, or nearly fo.

"When ftone-lime cannot be procured, chalk-lime, or fhell-lime, which beft refembles ftone-lime, in the characters above written of lime, may be ufed in the manner

(Q) "But they muft not be expofed to the rain until they are almoft as ftrong as frefh Portland ftone; and even then they ought to be fheltered from it as much as the circumftances will admit. Thefe ftones may be made very hard and beautiful, with a fmall expence of bone-afh, by foaking them, after they have dried thoroughly and hardened, in the lime liquor, and repeating this procefs twice or thrice, at diftant intervals of time. The like effect was experienced in incruftations.

(R) "In my experiments, mortar made with terras-powder, in the ufual method, does not appear to form fo ftrong a cement for water-fences as that made, according to the fpecification, with coarfe fand; and I fee no more reafon for avoiding the ufe of fand in terras-mortar, than there would be for rejecting ftone from the embankment. The bone-afhes meant in this place are the dark gray or black fort. I am not yet fully fatisfied about the operation of them in this inftance.

(S) "The qualities and ufes of fuch fine calcareous cement are recommended chiefly for the purpofe of fmoothing and finifhing the ftronger cruftaceous works, or for wafhing walls to a lively and uniform colour. For this laft intention, the mixture muft be as thin as new cream, and laid on brifkly with a brufh, in dry weather; and a thick and durable coat is to be made by repeated wafhing; but is not to be attempted by ufing a thicker liquor; for the coat made with this laft is apt to fcale, whilft the former endures the weather much longer than any other thin calcareous covering that has been applied in this way. Fine yellow-ochre is the cheapeft colouring ingredient for fuch wafh, when it is required to imitate Bath-ftone, or the warm-white ftones.

(T) "If fea-fand be well wafhed in frefh water, it is as good as any other round fand.

(U) "The cement made with thefe and the proper quantities of purified lime and lime-water, are inferior to the beft, as the grains of thefe powders are more perifhable and brittle than thofe of fand. They will not therefore be employed, unlefs for the fake of evafion, or for want of fand: in this latter cafe, the finer powder ought to be wafhed away.

(X) "This and the next paragraph is inferted with a view to evafions, as well as to fuggeft the eafier and cheaper methods which may be adopted in certain circumftances, by artifts who underftand the principles which I endeavoured to teach.

manner deſcribed, except that fourteen pounds and a half of chalk-lime will be required in the place of fourteen pounds of ſtone-lime. The proportion of lime which I have preſcribed above may be increaſed without inconvenience, when the cement or ſtucco is to be applied where it is not liable to dry quickly; and in the contrary circumſtance, this proportion may be diminiſhed; and the defect of lime in quantity or quality may be very advantageouſly ſupplied (Y), by cauſing a conſiderable quantity of the cementing liquor to ſoak into the work, in ſucceſſive portions, and at diſtant intervals of time, ſo that the calcareous matter of the cementing liquor, and the matter attracted from the open air, may fill and ſtrengthen the work.

"The powder of almoſt every well-dried or burnt animal ſubſtance may be uſed inſtead of bone-aſh; and ſeveral earthy powders, eſpecially the micaceous and the metallic; and the elixated aſhes of divers vegetables whoſe earth will not burn to lime; and the aſhes of mineral fuel, which are of the calcareous kind, but will not burn to lime, will anſwer the ends of bone-aſh in ſome degree.

"The quantity of bone-aſh deſcribed may be leſſened without injuring the cement, in thoſe circumſtances eſpecially which admit the quantity of lime to be leſſened, and in thoſe wherein the cement is not liable to dry quickly. And the art of remedying the defects of lime may be advantageouſly practiſed to ſupply the deficiency of bone aſh, eſpecially in building, and in making artificial ſtone with this cement."

STUD, in the manege, a collection of breeding horſes and mares.

STUDDING-SAILS, certain light ſails extended, in moderate and ſteady breezes, beyond the ſkirts of the principal ſails, where they appear as wings upon the yard arms.

STUFF, *in Commerce*, a general name for all kinds of fabrics of gold, ſilver, ſilk, wool, hair, cotton, or thread, manufactured on the loom; of which number are velvets, brocades, mohairs, ſatins, taffetas, cloths, ſerges, &c.

STUKELY, DR WILLIAM, a celebrated antiquarian, deſcended from an ancient family in Lincolnſhire, was born at Holbech in 1687, and educated in Bennet college, Cambridge. While an under graduate, he often indulged a ſtrong propenſity to drawing and deſigning; but made phyſic his principal ſtudy, and firſt began to practiſe at Boſton in his native country. In 1717 he removed to London, where, on the recommendation of Dr Mead, he was ſoon after elected a fellow of the Royal Society; he was one of the firſt who revived that of the antiquarians in 1718, and was their ſecretary for many years during his reſidence in town. In 1729 he took holy orders by the encouragement of Archbiſhop Wake; and was ſoon after preſented by Lord-chancellor King with the living of All-Saints in Stamford. In 1741 he became one of the founders of the Egyptian ſociety, which brought him acquainted with the benevolent duke of Montague, one of the members; who prevailed on him to leave Stamford, and preſented him to the living of St George the Martyr, Queen Square. He died of a ſtroke of the palſy in 1765. In his phyſical capacity, his Diſſertation on the Spleen was well received; and his *Itinerarium Curioſum*, the firſt fruit of his juvenile excurſions, was a good ſpecimen of what was to be expected from his riper age. His great learning, and profound reſearches into the dark remains of antiquity, enabled him to publiſh many elaborate and curious works: his friends uſed to call him the *arch-druid* of his age. His diſcourſes, intitled *Palæographia Sacra*, on the vegetable creation, beſpeak him a botaniſt, philoſopher, and divine.

STUM, in the wine-trade, denotes the unfermented juice of the grape after it has been ſeveral times racked off and ſeparated from its ſediment. The caſks are for this purpoſe well matched or fumigated with brimſtone every time, to prevent the liquor from fermenting, as it would otherwiſe readily do, and become wine. See MUST.

STUPIDITY. The Greek word μωροτης correſponds moſt with our Engliſh word *ſtupidity* or *fooliſhneſs*, when uſed to expreſs that ſtate of mind in which the intellects are defective. The immediate cauſes are ſaid to be, a deficiency of vital heat, or a defect in the brain. Stupid children ſometimes become ſprightly youths; but if ſtupidity continues to the age of puberty, it is hardly ever removed. If ſtupidity follows upon a violent paſſion, an injury done to the head, or other evident cauſe, and if it continues long, it becomes incurable. But the ſtupidity which conſiſts in a loſs of memory, and ſucceeds a lethargy, ſpontaneouſly ceaſes when the lethargy is cured.

STUPOR, a numbneſs in any part of the body, whether occaſioned by ligatures obſtructing the blood's motion, by the palſy, or the like.

STUPPA, or STUPE, in *Medicine*, is a piece of cloth dipped in ſome proper liquor, and applied to an affected part.

STURDY, a diſtemper to which cattle are ſubject, called alſo the *turning evil*. See FARRIERY *Index*.

STURGEON. See ACCIPENSER, ICHTHYOLOGY *Index*.

STURMIUS, JOHN, a learned philologer and rhetorician, was born at Sleida in Eifel near Cologne in 1507. He ſtudied at firſt in his native country with the ſons of Count de Manderſcheid, whoſe receiver his father was. He afterwards purſued his ſtudy at Liege in the college of St Jerom, and then went to Louvain in 1524. Five years he ſpent there, three in learning and two in teaching. He ſet up a printing-preſs with Rudger Reſcius profeſſor of the Greek tongue, and printed ſeveral Greek authors. He went to Paris in 1529, where he was highly eſteemed, and read public lectures on the Greek and Latin writers, and on logic. He married there, and kept a great number of boarders: but as he liked what were called the *new opinions*, he was more than once in danger; and this undoubtedly was the reaſon why he removed to Straſburg in 1537, in order to take poſſeſſion of the place offered him by the magiſtrates. The year following he opened a ſchool, which became

(Y) "This practice is noticed, as the remedy which may be uſed for the defects ariſing from evaſive meaſures, and as the method of giving ſpongy incruſtations containing bone-aſhes the greateſt degree of hardneſs."

became famous, and by his means obtained of Maximilian II. the title of an univerſity in 1566. He was very well ſkilled in polite literature, wrote Latin with great purity, and was a good teacher. His talents were not confined to the ſchool; for he was frequently intruſted with deputations in Germany and foreign countries, and diſcharged theſe employments with great honour and diligence. He ſhowed extreme charity to the refugees on account of religion: He not only laboured to aſſiſt them by his advice and recommendations; but he even impoveriſhed himſelf for them. He died in his 82d year, after he had been for ſome time blind. He publiſhed many books; the principal of which are, 1. *Partitiones Dialecticæ*. 2. *De Educatione Principum*. 3. *De Nobilitate Anglicana*. 4. *Linguæ Latinæ reſolvendæ Ratio*. 5. Excellent Notes on Ariſtotle's and Hermogenes's Rhetoric, &c.

He ought not to be confounded with *John Sturmius*, a native of Mechlin, and phyſician and profeſſor of mathematics at Louvain, who alſo wrote ſeveral works.

STURNUS, the STARLING; a genus of birds belonging to the order of paſſeres. See ORNITHOLOGY *Index*.

STYE, or STYTHE, in the eye. See CRITHE.

STYLE, a word of various ſignifications, originally deduced from *ſtylos*, a kind of bodkin wherewith the ancients wrote on plates of lead, or on wax, &c. and which is ſtill uſed to write on ivory-leaves and paper prepared for that purpoſe, &c.

STYLE, in dialling, denotes the gnomon or cock of a dial raiſed on the plane thereof to project a ſhadow.

STYLE, in *Botany*. See BOTANY.

STYLE, in language, is the peculiar manner in which a man expreſſes his conceptions. It is a picture of the ideas which riſe in his mind, and of the order in which they are there produced.

The qualities of a good ſtyle may be ranked under two heads; perſpicuity and ornament. It will readily be admitted, that perſpicuity ought to be eſſentially connected with every kind of writing; and to attain it, attention muſt be paid, firſt to ſingle words and phraſes, and then to the conſtruction of ſentences. When conſidered with reſpect to words and phraſes, it requires theſe three qualities; purity, propriety, and preciſion. When conſidered with regard to ſentences, it requires a clear arrangement of the words and unity in the ſenſe; to which, if ſtrength and harmony be added, the ſtyle will become ornamented.

One of the moſt important directions to be obſerved by him who wiſhes to form a good ſtyle, is to acquire clear and preciſe ideas on the ſubject concerning which he is to write or ſpeak. To this muſt be added frequency of compoſition, and an acquaintance with the ſtyle of the beſt authors. A ſervile imitation, however, of any author is carefully to be avoided; for he who copies, can hardly avoid copying faults as well as beauties. A ſtyle cannot be proper unleſs it be adapted to the ſubject, and likewiſe to the capacity of our hearers, if we are to ſpeak in public. A ſimple, clear, and unadorned ſtyle, ſuch as that of Swift, is fitteſt for intricate diſquiſition; a ſtyle elegant as Addiſon's, or impetuous like Johnſon's, is moſt proper for fixing the attention on truths, which, though known, are too much neglected. We muſt not be inattentive to the ornaments of ſtyle, if we wiſh that our labours ſhould be read and admired; but he is a contemptible writer, who looks not beyond the dreſs of language, who lays not the chief ſtreſs upon his matter, and who does not regard ornament as a ſecondary and inferior recommendation. For further obſervations on the different kinds of ſtyle, ſee ORATORY, N° 99, &c.

STYLE, in *Juriſprudence*, the particular form or manner of proceeding in each court of juriſdiction, agreeable to the rules and orders eſtabliſhed therein: thus we ſay, the ſtyle of the court of Rome, of chancery, of parliament, of the privy-council, &c.

STYLE, in *Muſic*, denotes a peculiar manner of ſinging, playing, or compoſing; being properly the manner that each perſon has of playing, ſinging, or teaching; which is very different both in reſpect of different geniuſes, of countries, nations, and of the different matters, places, times, ſubjects, paſſions, expreſſions, &c. Thus we ſay, the ſtyle of Paleſtrina, of Lully, of Corelli, of Handel, &c.; the ſtyle of the Italians, French, Spaniards, &c.

Old STYLE, the Julian method of computing time, as the

New STYLE is the Gregorian method of computation. See KALENDAR.

STYLEPHORUS CHORDATUS, a genus of fiſhes belonging to the order of apodes. See ICHTHYOLOGY *Index*, and Tranſactions of the Linnæan Society, vol. i.

STYLET, a ſmall dangerous kind of poniard which may be concealed in the hand, chiefly uſed in treacherous aſſaſſinations. The blade is uſually triangular, and ſo ſmall that the wound it makes is almoſt imperceptible.

STYLITES, PILLAR SAINTS, in eccleſiaſtical hiſtory, an appellation given to a kind of ſolitaries, who ſtood motionleſs upon the tops of pillars, raiſed for this exerciſe of their patience, and remained there for ſeveral years, amidſt the admiration and applauſe of the ſtupid populace. Of theſe we find ſeveral mentioned in ancient writers, and even as low as the twelfth century, when they were totally ſuppreſſed.

The founder of the order was St Simeon Stylites, a famous anchoret in the fifth century, who firſt took up his abode on a column ſix cubits high; then on a ſecond of twelve cubits, a third of twenty-two, a fourth of thirty-ſix, and on another of forty cubits, where he thus paſſed thirty-ſeven years of his life. The tops of theſe columns were only three feet in diameter, and were defended by a rail that reached almoſt to the girdle, ſomewhat reſembling a pulpit. There was no lying down in it. The faquirs, or devout people of the Eaſt, imitate this extraordinary kind of life to this day.

STYLOCERALOIDES, STYLO-GLOSSUS, *STYLO-Hyoidæus*, *STYLO-Pharyngæus*, STYLOIDES,	The names of different muſcles in the human body. See *Table of the Muſcles* under ANATOMY.

STYLOSANTHES, a genus of plants belonging to the *diadelphia* claſs, and in the natural method ranking under the 32d order, *Papilionaceæ*. See BOTANY *Index*.

STYPTIC, in *Pharmacy*, a medicine which by its aſtringency ſtops hæmorrhagies, &c. See MATERIA MEDICA *Index*.

STYRAX, the STORAX-TREE, a genus of plants belonging to the claſs *decandria*, and in the natural ſyſtem ranging

ranging under the 18th order, *bicornes*. See BOTANY and MATERIA MEDICA *Index*.

STYX, in *Fabulous Hiſtory*, a celebrated river of hell, round which it flows nine times. The gods held the waters of the Styx in ſuch veneration, that to ſwear by them was reckoned an oath altogether inviolable. If any of the gods had perjured themſelves, Jupiter obliged them to drink the waters of the Styx, which lulled them for one whole year into a ſenſeleſs ſtupidity, for the nine following years they were deprived of the ambroſia and the nectar of the gods, and after the expiration of the years of their puniſhment, they were reſtored to the aſſembly of the deities, and to all their original privileges. It is ſaid that this veneration was ſhown to the Styx, becauſe it received its name from the nymph Styx, who with her three daughters aſſiſted Jupiter in his war againſt the Titans.

Styx was a river which it was neceſſary for departed ſhades to paſs before they could enter the infernal regions; and it was the office of Charon to ferry them over in a boat which was kept for that purpoſe. The ghoſts of thoſe who had not been honoured with the rites of ſepulture were obliged to wander an hundred years before Charon could admit them into his boat to convey them before the judges of Hades. What could have given riſe to this fable of Charon and his boat, it is not very material to inquire. Mythological writers have ſaid, that the Greeks learned it from the Egyptians, which is indeed probable enough; that the Egyptians framed both this, and ſome other fables relating to the dead, from certain cuſtoms peculiar to their country; that in particular there was, not far from Memphis, a famous burying-place, to which the dead bodies were conveyed in a boat acroſs the lake Acheruſia; and that Charon was a boatman who had long officiated in that ſervice. The learned Dr Blackwell ſays, in his life of Homer, that, in the old Egyptian language, *Charoni* ſignified "ferryman."

Tranſactions of the Royal Society of Edinburgh, vol. ii.

SUABIA, a circle of Germany, bounded on the north by the circle of Franconia and that of the Lower Rhine; on the weſt by the circle of the Lower Rhine and Alſace; on the ſouth by Switzerland; and on the eaſt by the circle of Bavaria. Of all the circles of the empire, Suabia is the moſt divided; it contains four eccleſiaſtic and thirteen lay principalities, nineteen independent prelacies and abbeys, twenty-ſix earldoms and lordſhips, and thirty-one free cities. The prime directors of the circle, as they are termed, were formerly the biſhop of Conſtance and the duke of Wirtemberg. But this circle has ſuffered ſimilar changes with neighbouring ſtates.

The mixture of the various forms of government and religious ſects; the oppreſſion exerciſed by the great on the poor; the game conſtantly played by the emperor, who poſſeſſes many pieces of detached country in Suabia, which depend not on the circle, and can, in conſequence of his privileges as archduke of Auſtria, extend his poſſeſſions in it by various ways; are circumſtances (ſays Baron Rieſbeck) which give the cultivation of the country, and the character of the inhabitants, a moſt extraordinary caſt. In ſeveral of the poſt towns where you ſtop, you ſee the higheſt degree of cultivation in the midſt of the moſt ſavage wildneſs; a great degree of knowledge and poliſh of manners, mixed with the groſſeſt ignorance and ſuperſtition; traces of liberty, under the deepeſt oppreſſion; national pride, together with the contempt and neglect of the native country; in ſhort, all the ſocial qualities in ſtriking contraſt and oppoſition to each other. Thoſe parts of Suabia which belong to the great potentates, ſuch as Wirtemberg, Auſtria, and Baden, are certainly the moſt improved. The whole of Suabia may comprehend about nine hundred German ſquare miles, and two millions of people. More than half of theſe are ſubjects of the three above mentioned princes, though they are not proprietors of near one half of the lands.

Baron Rieſbeck's Travels through Germany, vol. i.

SUARES, FRANCIS, a Jeſuit, was born in Granada on the 5th of January 1548. He was a profeſſor of theology at Alcala, Salamanca, Rome, and Coimbra in Portugal. He died at Liſbon in 1617 with the greateſt reſignation; "I never thought (ſaid he) that it was ſo eaſy to die." His memory was aſtoniſhing, he could repeat the whole of his voluminous works by heart. His writings fill 23 folio volumes, and are moſtly on theological and moral ſubjects. His Treatiſe of Laws has been reprinted in this country. His Defence of the Catholic Faith againſt the Errors of England was written at the requeſt of Pope Paul V. This book was publicly burnt at London by order of James I. When Suares heard it, he is ſaid to have exclaimed, "O that I too could ſeal with my blood the truths which I have defended with my pen!"

SUBAH, the general name of the viceroyſhips, or greater governments, into which the Mogul empire was divided, conſiſting of ſeveral provinces. The juriſdiction of a ſubahdar, the ſame as ſubahſhip, ſubaedaree, or nizamut.

SUBAHDAR, the viceroy, lord-lieutenant, or governor, holding a ſubah; the ſame as nabob or nazim. Alſo the black commander of a company of ſeapoys.

SUBALTERN, a ſubordinate officer, or one who diſcharges his poſt under the command and ſubject to the direction of another; ſuch are lieutenants, ſublieutenants, cornets, and enſigns, who ſerve under the captain.

SUBCLAVIAN, in *Anatomy*, is applied to any thing under the armpit or ſhoulder, whether artery, nerve, vein, or muſcle.

SUBDEACON, an inferior miniſter, who anciently attended at the altar, prepared the ſacred veſſels, delivered them to the deacons in time of divine ſervice, attended the doors of the church during communion-ſervice, went on the biſhop's embaſſies with his letters or meſſages to foreign churches, and was inveſted with the firſt of the holy orders. They were ſo ſubordinate to the ſuperior rulers of the church, that, by a canon of the council of Laodicea, they were forbidden to ſit in the preſence of a deacon without his leave. According to the canons, a perſon muſt be twenty-two years of age to be promoted to the order of ſubdeacon. See DEACON.

SUBDOMINANT, in *Muſic*, a name given by M. Rameau to the fourth note of the tone, which of conſequence is the ſame interval from the tonic when deſcending as the dominant in riſing. This denomination ariſes from the affinity which this author finds by inverſion between the minor mode of the ſubdominant and the major mode of the tonic.

SUBDUPLE RATIO, is when any number or quantity is contained in another twice. Thus 3 is ſaid to be ſubduple of 6, as 6 is duple of 3. See RATIO.

SUBDUPLICATE RATIO of any two quantities, is the ratio of their square roots.

SUBER, the CORK-TREE. See QUERCUS, BOTANY *Index*.

SUBJECT, a person under the rule and dominion of a sovereign prince or state.

SUBJECT is also used for the matter of an art or science, or that which it considers, or whereon it is employed: thus the human body is the subject of medicine.

SUBINFEUDATION, was where the inferior lords, in imitation of their superiors, began to carve out and grant to others minuter estates than their own, to be held of themselves; and were so proceeding downwards *in infinitum*, till the superior lords observed, that by this method of subinfeudation they lost all their feodal profits, of wardships, marriages, and escheats, which fell into the hands of these mesne or middle lords, who were the immediate superiors of the terre-tenant, or him who occupied the land. This occasioned the stat. of Westm. 3. or *quia emptores*, 18. Edw. I. to be made; which directs, that, upon all sales or feoffments of lands, the feoffee shall hold the same, not of his immediate feoffer, but of the chief lord of the fee of whom such feoffer himself held it. And from hence it is held, that all manors existing at this day must have existed by immemorial prescription; or at least ever since the 18 Edw. I. when the statute of *quia emptores* was made.

Blackst. Commentary, vol. ii.

SUBITO, in the Italian music, is used to signify that a thing is to be performed quickly and hastily: thus we meet with *volti subito*, turn over the leaf quickly.

SUBJUNCTIVE, in *Grammar*. See GRAMMAR.

SUBLIMATE, a chemical preparation, consisting of quicksilver united with muriatic acid. See MERCURY, CHEMISTRY *Index*.

SUBLIMATION, in *Chemistry*, the condensing and collecting, in a solid form, by means of vessels aptly constructed, the fumes of bodies raised from them by the application of a proper heat.

SUBLIME, or SUBLIMITY. See the article GRANDEUR and SUBLIMITY.

SUBLINGUAL ARTERY. See ANATOMY.

SUBLINGUAL Glands, in *Anatomy*, two glands under the tongue, placed one on each side thereof.

SUBMULTIPLE, in *Geometry*, &c. A submultiple number, or quantity, is that which is contained a certain number of times in another, and which, therefore, repeated a certain number of times, becomes exactly equal thereto. Thus 3 is a submultiple of 21. In which sense a submultiple coincides with an aliquot part.

SUBMULTIPLE Ratio, is that between the quantity contained and the quantity containing. Thus the ratio of 3 to 21 is submultiple. In both cases submultiple is the reverse of multiple: 21, *e. gr.* being a multiple of 3, and the ratio of 21 to 3 a multiple ratio.

SUBORDINARIES. See HERALDRY, Chap. III. Sect. II.

SUBORDINATION, a relative term, expressing an inferiority betwixt one person and another.

SUBORNATION, in *Law*, a secret, underhand, preparing, instructing, or bringing in a false witness; and from hence *subornation of perjury* is the preparing or corrupt alluring to perjury. The punishment for this crime was formerly death, then banishment or cutting out the tongue, afterwards forfeitures of goods; and it is now a fine and imprisonment, and never more to be received as evidence. The statute 2 Geo. II. c. 25. superadded a power for the court to order the offender to be sent to the house of correction for a term not exceeding seven years, or be transported for the same period.

SUBPOENA, in *Law*, a writ whereby common persons are called into chancery, in such cases where the common law hath provided an ordinary remedy; and the name of it proceeds from the words therein, which charge the party called to appear at the day and place affirmed, *sub pœna centum librarum*, &c. The subpœna is the leading process in the courts of equity; and by statute, when a bill is filed against any person, process of subpœna shall be taken out to oblige the defendant to appear and answer the bill, &c.

SUBPOENA ad testificandum, a writ or process to bring in witnesses to give their testimony. If a witness on being served with this process does not appear, the court will issue an attachment against him; or a party, plaintiff or defendant, injured by his non-attendance, may maintain an action against the witness. See *Blackst. Com.* vol. viii. p. 369.

SUBPOENA, in *Equity*, a process in equity, calling on a defendant to appear and answer to the complainant's bill. See statute 5th Geo. II. c. 25. which enacts, that where the party cannot be found to be served with a subpœna, and absconds (as is believed) to avoid being served, a day shall be appointed him to appear to the bill of the plaintiff; which is to be inserted in the London Gazette, read in the parish church where the defendant last lived, and fixed up at the Royal Exchange: and if the defendant doth not appear upon that day, the bill shall be taken *pro confesso*.

SURREPTITIOUS, a term applied to a letter, licence, patent, or other act, fraudulently obtained of a superior, by concealing some truth which, had it been known, would have prevented the concession or grant.

SUBROGATION, or SURROGATION, in the civil law, the act of substituting a person in the place, and intitling him to the rights, of another. In its general sense, subrogation implies a succession of any kind, whether of a person to a person, or of a person to a thing.

There are two kinds of subrogation: the one *conventional*, the other *legal*. *Conventional* subrogation is a contract whereby a creditor transfers his debt, with all appurtenances thereof, to the profit of a third person. *Legal* subrogation is that which the law makes in favour of a person who discharges an antecedent creditor; in which case there is a legal translation of all rights of the ancient creditor to the person of the new one.

SUBSCRIPTION, in general, signifies the signature put at the bottom of a letter, writing, or instrument.

In commerce, it is used for the share or interest which particular persons take in a public stock or a trading company, by writing their names, and the shares they require, in the books or register thereof.

SUBSCRIPTION to articles of faith is required of the clergy of every established church, and of some churches not established. Whether such subscription serves any good purpose, in a religious or theological view, is a very doubtful question. It may be necessary in an establishment, as a test of loyalty to the prince, and of attachment to the constitution, civil and ecclesiastical, but it cannot produce

produce uniformity of opinion. As all language is more or leſs ambiguous, it becomes difficult, if not impoſſible, to determine in what ſenſe the words of long eſtabliſhed creeds are to be interpreted; and we believe that the clergy of the churches of England and Scotland ſeldom conſider themſelves as fettered by the Thirty-nine Articles, or the Confeſſion of Faith, when compoſing inſtructions either for their reſpective pariſhes or for the public at large. See INDEPENDENTS.

SUBSCRIPTION, in the commerce of books, ſignifies an engagement to take a certain number of copies of a book, intended to be printed, and a reciprocal obligation of the bookſeller or publiſher to deliver the ſaid copies, on certain terms. Theſe ſubſcriptions, which had their riſe in England about the middle of the 17th century, were lately very frequent in France and Holland, and are now very common among ourſelves.

SUBSEQUENT, ſomething that comes after another, particularly with regard to the order of time.

SUBSIDY, in *Law*, ſignifies an aid or tax granted to the king by parliament, for the neceſſary occaſions of the kingdom; and is to be levied on every ſubject of ability, according to the rate or value of his lands or goods: but this word, in ſome of our ſtatutes, is confounded with that of cuſtoms. See TAX.

SUBSTANCE, the ſubjects to which we ſuppoſe qualities belong. Thus gold is the ſubſtance to which the qualities of ductility, yellowneſs, denſity, &c. belong. See METAPHYSICS, n° 145.

SUBSTANTIAL, in the ſchools, ſomething belonging to the nature of ſubſtance.

SUBSTANTIVE, in *Grammar*. See GRAMMAR.

SUBSTITUTE, a perſon who officiates for another in his abſence.

SUBSTITUTION, in the *Civil Law*, a diſpoſition of a teſtament, whereby the teſtator ſubſtitutes one heir for another, who has only the uſufruct, and not the property or the thing, left him.

SUBSTRACTION, or SUBTRACTION, in *Arithmetic*, the ſecond rule, or rather operation, in arithmetic, whereby we deduct a leſs number from a greater, to learn their preciſe difference. See ARITHMETIC and ALGEBRA.

SUBTANGENT OF A CURVE, the line that determines the interſection of a tangent with the axis; or that determines the point wherein the tangent cuts the axis prolonged.

SUBTENSE, formed from *ſub* "under," and *tendo* "I ſtretch," in *Geometry*, a right line which is oppoſite to an angle, and drawn between the two extremities of the arch which meaſures that angle.

SUBTERRANEOUS, whatever is under ground: thus naturaliſts ſpeak of ſubterraneous fires, ſubterraneous damps, &c.

SUBTERRANEOUS Cavern. See QUARRIES.

SUBTILE, in *Phyſics*, an appellation given to whatever is extremely ſmall, fine, and delicate; ſuch as the animal ſpirits, the effluvia of odorous bodies, &c. are ſuppoſed to be.

SUBULARIA, ROUGH-LEAVED ALYSSON, or *Awlwort*, a genus of plants belonging to the claſs tetradynamia, and in the natural order ranging under the 39th order, *ſiliquoſæ*. See BOTANY *Index*.

SUBULATED, ſomething ſhaped like an awl.

SUCCEDANEUM, in *Pharmacy*, denotes a drug ſubſtituted in the place of another.

SUCCESSION, in *Metaphyſics*, the idea which we get by reflecting on the ideas that follow one another in our mind; and from the ſucceſſion of ideas we get the idea of *time*. See METAPHYSICS, N° 93. and 209.

SUCCESSION, in *Law*. See DESCENT.

SUCCESSION to the Crown. See *HEREDITARY Right*.—From the days of Egbert, the firſt ſole monarch of England, even to the preſent, the four cardinal maxims mentioned in that article have ever been held conſtitutional canons of ſucceſſion. It is true, as Sir William Blackſtone obſerves, this ſucceſſion, through fraud or force, or ſometimes through neceſſity, when in hoſtile times the crown deſcended on a minor or the like, has been very frequently ſuſpended; but has generally at laſt returned back into the old hereditary channel, though ſometimes a very conſiderable period has intervened. And even in thoſe inſtances where this ſucceſſion has been violated, the crown has ever been looked upon as hereditary in the wearer of it. Of which the uſurpers themſelves were ſo ſenſible, that they for the moſt part endeavoured to vamp up ſome feeble ſhow of a title by deſcent, in order to amuſe the people, while they gained the poſſeſſion of the kingdom. And, when poſſeſſion was once gained, they conſidered it as the purchaſe or acquiſition of a new eſtate of inheritance, and tranſmitted, or endeavoured to tranſmit it, to their own poſterity by a kind of hereditary right of uſurpation. (See Black. Com. vol. i. 197—217.). From the hiſtorical view there given, it appears that the title to the crown is at preſent hereditary, though not quite ſo abſolutely hereditary as formerly: and the common ſtock or anceſtor, from whom the deſcent muſt be derived, is alſo different. Formerly the common ſtock was King Egbert; then William the Conqueror; afterwards, in James I.'s time, the two common ſtocks united; and ſo continued till the vacancy of the throne in 1688: now it is the Princeſs Sophia in whom the inheritance was veſted by the new king and parliament. Formerly, the deſcent was abſolute, and the crown went to the heir without any reſtriction: but now, upon the new ſettlement, the inheritance is conditional: being limited to ſuch heirs only, of the body of the Princeſs Sophia, as are Proteſtant members of the church of England, and are married to none but Proteſtants.

And in this due medium conſiſts the true conſtitutional notion of the right of ſucceſſion to the imperial crown of theſe kingdoms. The extremes between which it ſteers are each of them equally deſtructive of thoſe ends for which ſocieties were formed and kept on foot. Where the magiſtrate, upon every ſucceſſion, is elected by the people, and may by the expreſs proviſion of the laws be depoſed (if not puniſhed) by his ſubjects, this may ſound like the perfection of liberty, and look well enough when delineated on paper; but in practice will be ever productive of tumult, contention, and anarchy. And, on the other hand, divine indefeaſible hereditary right, when coupled with the doctrine of unlimited paſſive obedience, is ſurely of all conſtitutions the moſt thoroughly ſlaviſh and dreadful. But when ſuch an hereditary right as our laws have created and veſted in the royal ſtock, is cloſely interwoven with thoſe liberties which are equally the inheritance of the ſubject; this union

union will form a conſtitution, in theory the moſt beautiful of any, in practice the moſt approved, and, we truſt, in duration the moſt permanent.

In France the ſucceſſion to the monarchy was limited to heirs male (ſee SALIC); but in Navarre the crown was inherited by the heir of line, whether male or female. The caſe ſtands thus: Philip the Fourth, king of France, ſurnamed *the Fair*, in the year 1285 eſpouſed Jane queen of Navarre in her own right; and as king conſort of this latter kingdom added the title of Navarre to his former one of France. Louis X. ſon and heir of Philip and Jane (ſurnamed *Hutin* or the *Boiſterous*), ſucceeded to both crowns. By Margaret his firſt wife, who had been crowned queen of Navarre, he left one daughter, Joan or Jane. His ſecond wife Clementina was pregnant at the time of his deceaſe, and was delivered of a poſthumous ſon, whom moſt of the French annaliſts recognize as John I. of France, though he lived no longer than three weeks. On his death the kingdom of France paſſed to Philip V. (ſurnamed *the Long*), and that of Navarre (to which the Salic law could by no conſtruction extend) to Joanna the only child and heir of Louis and Margaret. From Joanna, in lineal ſucceſſion, the kingdom of Navarre paſſed to Jane d'Albret, mother of Henry IV. of France, and wife of Anthony of Vendoſme, who as king conſort wore the crown of Navarre. On the acceſſion of Henry to the kingdom of France, the two monarchies were united, and the four ſucceeding princes aſſumed the joint titles.

SUCCINIC ACID, an acid extracted from amber by ſublimation in a gentle heat, and which riſes in a concrete form into the neck of the ſubliming veſſel. See CHEMISTRY *Index*.

SUCCINUM, AMBER, in *Mineralogy*, a ſpecies of bitumen claſſed under the inflammable ſubſtances. See MINERALOGY *Index*.

SUCCORY. See CICHORIUM, BOTANY *Index*.

SUCCOTH, in *Ancient Geography*, a town which lay between the brook Jabbok and the river Jordan, where Jacob fixed his tents. There was another Succoth, where the Iſraelites firſt encamped after their departure from Rameſes towards the Red ſea. Succoth ſignifies *tents*.

SUCCUBUS, a term uſed by ſome writers for a dæmon who aſſumes the ſhape of a woman, and as ſuch lies with a man; in which ſenſe it ſtands oppoſed to *incubus*, which was a dæmon in form of a man, that lies with a woman. But the truth is, the ſuccubus is only a ſpecies of the nightmare. See MEDICINE, N° 329.

SUCCULA, in *Mechanics*, an axis or cylinder, with ſtaves in it to move it round; but without any tympanum or peritrochium.

SUCCULENT PLANTS, among botaniſts, ſuch whoſe leaves are thick and full of juice.

SUCKER. See CYCLOPTERUS, ICHTHYOLOGY *Index*.

SUCKERS, in *Gardening*, the ſame with OFFSETS.

SUCKING-FISH. See ECHENEIS, ICHTHYOLOGY *Index*.

SUCKLING, SIR JOHN, an Engliſh poet and dramatic writer, was the ſon of Sir John Suckling, comptroller of the houſehold to King Charles I. and born at Witham in Eſſex in 1613. He diſcovered an uncommon propenſity to the acquiring of languages, inſomuch that he is reported to have ſpoken Latin at five years of age, and to have written it at nine. When he grew up, he travelled; but ſeems to have affected nothing more than the character of a courtier and fine gentleman; which he ſo far attained, that he was allowed to have the peculiar happineſs of making every thing he did become him. In his travels he made a campaign under the great Guſtavus Adolphus; and his loyalty, if not his valour, appeared in the beginning of our civil wars; for, after his return to England, he raiſed a troop of horſe for the king's ſervice entirely at his own charge; and mounted them ſo completely and richly, that they are ſaid to have coſt him 12,000l. This troop, with Sir John at its head, behaved ſo ill in the engagement with the Scots, upon the Engliſh borders, in 1639, as to occaſion the famous lampoon compoſed by Sir John Mennis; " Sir John he got him an ambling nag," &c. This ballad, which was ſet to a briſk tune, was much ſung by the parliamentarians, and continues to be ſung to this day. This diſaſtrous expedition, and the ridicule that attended it, was ſuppoſed to have haſtened his death; being ſeized by a fever, of which he died, at 28 years of age. He was a ſprightly wit, and an eaſy verſifier, but no great poet. His works, conſiſting of a few poems, letters, and plays, have nevertheleſs gone through ſeveral editions.

SUCTION, the act of ſucking or drawing up a fluid, as air, water, milk, or the like, by means of the mouth and lungs; or, in a ſimilar manner, by artificial means. See PNEUMATICS and HYDRODYNAMICS.

SUDATORY, a name given by the ancient Romans to their hot or ſweating rooms; ſometimes alſo called *Laconica*.

SUDEROE. See *FERRO-Iſlands*.

SUDORIFIC, an appellation given to any medicine that cauſes or promotes ſweat.

SUESSIONES, a branch of the Remi, a people of Gallia Belgica (Pliny); called ſometimes *Sueſſones*, in the lower age *Sueſſi*; ſituated between the Remi to the eaſt, the Nervii to the north, the Veromandui to the weſt, and the Meldæ to the ſouth, in the tract now called *le Soiſſonois*.—*Sueſſiones*, *Sueſſones*, and *Sueſſonæ*, the name of their city in the lower age; thought to have been formerly called *Noviodunum* (Cæſar), is now called *Soiſſons*.

SUET, SEVUM, or *Sebum*, in *Anatomy*, the ſolid fat found in ſeveral animals, as ſheep, oxen, &c. but not in the human ſpecies. See the article FAT.—It is of the ſevum that tallow is made.

SUETONIUS TRANQUILLUS, CAIUS, a famous Latin hiſtorian, was born at Rome, and became ſecretary to the emperor Adrian, about the 118th year of the Chriſtian era; but that poſt was taken from him three years after, when ſeveral perſons fell under that prince's diſpleaſure for not ſhowing the empreſs Sabina all the reſpect ſhe deſerved. During his diſgrace he compoſed many works, which are loſt. Thoſe now extant are his Hiſtory of the XII firſt Emperors, and a part of his treatiſe of the Illuſtrious Grammarians and Rhetoricians. Pliny the Younger was his intimate friend, and perſuaded him to publiſh his books. His Hiſtory of the XII Roman Emperors has been much commended by moſt of our polite ſcholars. He repreſents, in a continued ſeries of curious and intereſting particulars, without any digreſſions or reflections, the actions of the emperors, without omitting their vices, which he expoſes with all their deformity, and with the fame freedom mentions the good qualities of the very fame perfons; but the horrid diffolutenefs and obfcene actions he relates of Tiberius, Caligula, Nero, &c. have made fome fay, that he wrote the lives of the emperors with the fame licentioufnefs with which they lived. The edition of this hiftory procured by Grævius at Utrecht in 1672, with the excellent Commentaries of Torrentius and Cafaubon, and the notes of fome other learned critics, is much efteemed. Burman alfo publifhed an edition in 2 vols. 4to, with notes.

SUEVI, the Catti or Chatti of Cæfar (Strabo), placed on the Rhine: the reafon of Cæfar's calling them thus does not appear, though confiderably diftant from the proper Suevi or Alemanni.

SUEVI, (Tacitus), a common name of the people fituated between the Elbe and the Viftula, diftinguifhed otherwife by particular names; as in Ptolemy, *Suevi Angeli*, *Suevi Sennones*.

SUEVUS, in *Ancient Geography*, a river of Germany, thought to be the fame with the Viadrus or Oder, emptying itfelf at three mouths into the Baltic, the middlemoft of which is called *Swine* or *Swene;* which laft comes nearer the name *Suevus*.

SUEZ, a fmall fea-port town, fituated near the northern extremity of the Red fea, and about 30 hours journey eaft from Cairo. The country around it is a fandy plain, without the fmalleft fpot of verdure. The only water which can be drunk is brought from El-Naba, or the fpring, at the diftance of three hours journey; and it is fo brackifh, that without a mixture of rum it is infupportable to Europeans. The town itfelf is a collection of miferable ruins, the khans being the only folid buildings; yet from March till June, the feafon when the Jidda and Yambo fleet arrives, the town becomes crowded; but after its departure nobody remains except the governor, who is a Mamlouk, 12 or 14 perfons who form his houfehold, and the garrifon. The fortrefs is a defencelefs heap of ruins, which the Arabs confider as a citadel, becaufe it contains fix brafs fourpounders, and two Greek gunners, who turn their heads afide when they fire. The harbour is a wretched quay, where the fmalleft boats are unable to reach the fhore, except at the higheft tides. There, however, the merchandife is embarked, to convey it over the banks of fand to the veffels which anchor in the road. This road, fituated a league from the town, is feparated from it by a fhore which is left dry at low water; it has no works for its defence, fo that the veffels which M. Volney tells us he has feen there, to the number of 28 at a time, might be attacked without oppofition; for the fhips themfelves are incapable of refiftance, none having any other artillery than four rufty fwivels.

Volney's Travels, vol. i.

Suez has always been, notwithftanding its local difadvantages, a place of great trade, on account of its geographical fituation. It was by the gulf of Suez that the commodities of India were formerly conveyed to Europe, till the difcovery of the paffage by the Cape of Good Hope converted that trade into a new channel. As the ifthmus of Suez, which feparates the Red fea from the Mediterranean, is not more than 57 miles, it has been frequently propofed to join thefe two feas together by a canal. As there are no mountains nor remarkable inequalities of furface, this plan would at firft view appear eafy to be executed. But though the difference of levels would not prevent a junction, the great difficulty arifes from the nature of the correfponding coafts of the Mediterranean and the Red fea, which are of a low and fandy foil, where the waters form lakes, fhoals, and moraffes, fo that veffels cannot approach within a confiderable diftance. It will therefore be found fcarcely poffible to dig a permanent canal amid thefe fhifting fands: not to mention, that the fhore is deftitute of harbours, which muft be entirely the work of art. The country befides has not a drop of frefh water, and to fupply the inhabitants, it muft be brought as far as from the Nile.

The beft and only method therefore of effecting this junction, is that which has been already fuccefsfully practifed at different times; which is, by making the river itfelf the medium of communication, for which the ground is perfectly well calculated; for Mount Mokattum fuddenly terminating in the latitude of Cairo, forms only a low and femicircular mound, round which is a continued plain from the banks of the Nile as far as the point of the Red fea. The ancients, who early underftood the advantage to be derived from this fituation, adopted the idea of joining the two feas by a canal connected with the river. Strabo * obferves, that this was firft executed under Sefoftris, who reigned about the time of the Trojan war; and this work was fo confiderable as to occafion it to be remarked, "that it was 100 cubits (or 170 feet) wide, and deep enough for large veffels." After the Greeks conquered the country, it was reftored by the Ptolemies, and again renewed by Trajan. In fhort, even the Arabs themfelves followed thefe examples. "In the time of Omar ebn-el-Kattab (fays the hiftorian El Makin), the cities of Mecca and Medina fuffering from famine, the caliph ordered Amrou governor of Egypt to cut a canal from the Nile to Kolzoum, that the contributions of corn and barley appointed for Arabia might be conveyed that way."

* Lib. xvii.

This canal is the fame which runs at prefent to Cairo, and lofes itfelf in the country to the north-eaft of Berket-el-Hadj, or the Lake of the Pilgrims.

The place on the weft coaft of the gulf of Suez, where the children of Ifrael are fuppofed to have entered it, is called *Badea*, about fix miles to the north of Cape Korondel, on the other fide of the gulf, as we are informed in a letter from the ingenious Edward Wortley Montague, F. R. S. to Dr Watfon, containing an account of his journey from Cairo to the Written Mountains in the defert of Sinai. Oppofite to Badea is a ftrong current which fets to the oppofite fhore, about fouth-eaft, with a whirlpool called *Birque Pharaone*, the *well* or *pool of Pharaoh*, being the place where his hoft is faid to have been deftroyed. We are told by the fame gentleman, that the Egyptian fhore from Suez to Badea is fo rocky and fteep, that there was no entering upon the gulf but at one of thefe two places.

The Britifh nation, we believe, never attempted to carry on commerce with any of the ports of the Red fea beyond Jidda, till, on the fuggeftion of Mr Bruce, in 1776, fome Britifh merchants at Bengal equipped two or three veffels for Suez, laden with piece-goods of Bengal and coaft manufactures. The command of the veffels was committed to Captain Greig, a meritorious feaman; and the management of the goods was entrufted to Mr Shaw, a gentleman diftinguifhed for his mercantile knowledge. The fale turned out to advantage; but fuch

fuch great expences were incurred in making prefents to the bey of Cairo and Suez, as to confume the whole profits gained by the fale of the cargo. The great purpofe of the expedition was, however, accomplifhed, as a firman was obtained from the government of Cairo to trade by the way of Suez. In confequence of this, three fhips went to Suez the following year, and as many in 1778. The opening of this trade alarmed the jealoufy of the Eaft India Company; they applied to our government, and orders were given to relinquifh this promifing commerce. Thefe orders reached Egypt fooner than Bengal, and the confequence was fatal to the unfortunate adventurers who vifited Suez that year (1779). By a plan concerted between the beys, a large body of Bedouin Arabs attacked the caravan paffing from Suez to Cairo with goods valued at 12 lacks of rupees. The goods were plundered, the Europeans were ftripped and left naked in the defert, expofed to the burning rays of the fun, without a drop of water to quench their thirft, or food to fupport life. Moft of them died, and fome of their bodies were afterwards found mangled and disfigured by wolves. We have been favoured with a particular account of the fufferings of our countrymen by a correfpondent, which, we are forry, we have not room to infert. Thofe who wifh to obtain a more full account may confult the Annual Regifter for 1781 or 1782.

SUFFETULA, in *Ancient Geography*, a town of Africa, in the dominions of Carthage; probably fo called from Suffetes, the title of the magiftrates of that city. It is now called *Spaitla*, in the kingdom of Tunis, and has many elegant remains of antiquity. There are three temples in a great meafure entire; one of them of the Compofite order, the other two Corinthian. "A beautiful and perfect capital of the Compofite order (fays Mr Bruce), the only perfect one that now exifts, is defigned in all its parts in a very large fize; and with the detail of the reft of the ruin, is a precious monument of what that order was, now in the collection of the king." The town itfelf (he fays) is fituated in the moft beautiful fpot in Barbary, furrounded by great numbers of juniper-trees, and watered by a pleafant ftream, which finks under the earth at that place, without appearing any more.

SUFFOCATION, the privation of the function of refpiration or breathing. See the articles DROWNING, HANGING, &c.

SUFFOLK, a county of England. Its name is contracted from *Southfolk*, fo called from its fituation in regard to Norfolk. It is bounded on the weft by Cambridge-fhire; on the fouth by Effex, from which it is parted by the river Stour; on the eaft by the German ocean; and on the north by Norfolk, feparated from it by the Leffer Oufe and the Waveney. From weft to eaft it is 52 miles in length, about 20 at a medium in breadth, and 196 in circumference. It contains 22 hundreds, 29 market-towns, 575 parifhes, upwards of 34,000 houfes, and 210,431 inhabitants. The whole is divided into two parts, viz. the Liberty of St Edmund, and the Geldable; the former of which contains the weft parts of the county, and the other the eaft; and there is a grand jury for each at the affizes. The air is reckoned as wholefome and pleafant as any in the kingdom, nor is it otherwife upon the fea coaft, which is dry and fandy, and free from falt marfhes. The foil, except to the weft and upon the fea-coaft, is very rich, being a compound of clay and marle. Towards the fea there are large heaths and tracts of fand; but thefe produce hemp, rye, and peafe, and feed great flocks of fheep. About Newmarket the foil is much the fame; but in high Suffolk or the woodlands, befides wood, there are very rich paftures, where abundance of cattle are fed. In other parts of the county, as about Bury, there is plenty of corn. As this county is noted for the richnefs of its paftures, fo is it for butter and cheefe, efpecially the former, which is faid to be remarkably good; fo that being packed up in firkins, it is fold for all ufes both by fea and land, and conveyed to many parts of England, efpecially to London. The inland parts of the county are well fupplied with wood for fuel, and thofe upon the fea-coaft with coals from Newcaftle. The manufactures of the county are chiefly woollen and linen cloth. It lies in the diocefe of Norwich, has two archdeacons, viz. of Sedbury and Suffolk; gives title of earl to a branch of the Howards; fends two members to parliament for the county, and two for each of the following places, Ipfwich, Dunwich, Orford, Aldborough, Sudbury, Eye, and St Edmund's-Bury. The county is extremely well watered by the following rivers, which either traverfe its borders, or run acrofs into the German ocean, viz. the Leffer Oufe, the Waveney, the Blithe, the Deben, the Orwell or Gipping, and the Stour.

Gough's edition of Camden's Britannia.

SUFFRAGAN, an appellation given to fimple bifhops with regard to archbifhops, on whom they depend, and to whom appeals lie from the bifhops courts.

Suffragan is likewife the appellation given to a bifhop, who is occafionally appointed to refide in a town or village, and affift the diocefan.

SUFFRAGE, denotes a vote given in an affembly, where fomething is deliberated on, or where a perfon is elected to an office or benefice.

SUFFRUTEX, among botanifts, denotes an underfhrub, or the loweft kind of woody plants, as lavender.

SUGAR, a folid fweet fubftance obtained from the juice of the fugar-cane; or, according to chemifts, an effential falt, capable of cryftallization, of a fweet and agreeable flavour, and contained in a greater or lefs quantity in almoft every fpecies of vegetables, but moft abundant in the fugar-cane.

1 Value of fugar.

As the fugar-cane is the principal production of the Weft Indies, and the great fource of their riches; as it is fo important in a commercial view, from the employment which it gives to feamen, and the wealth which it opens for merchants; and befides now is become a neceffary of life—it may juftly be efteemed one of the moft valuable plants in the world. The quantity confumed in Europe is eftimated at nine millions fterling, and the demand would probably be greater if it could be fold at a reduced price. Since fugar then is reckoned fo precious a commodity, it muft be an object of defire to all perfons of curiofity and refearch, to obtain fome general knowledge of the hiftory and nature of the plant by which it is produced, as well as to underftand the procefs by which the juice is extracted and refined. We will therefore firft inquire in what countries it originally flourifhed, and when it was brought into general ufe, and became an article of commerce.

From the few remains of the Grecian and Roman authors which have furvived the ravages of time, we can find no proofs that the juice of the fugar-cane was known

Sugar.

2 was probably known to the ancient Jews.

at a very early period. There can be no doubt, however, that in thoſe countries where it was indigenous its value was not long concealed. It is not improbable that it was known to the ancient Jews; for there is ſome reaſon to ſuppoſe, that the Hebrew word קנה, which occurs frequently in the Old Teſtament, and is by our tranſlators rendered ſometimes *calamus* and ſometimes *ſweet-cane*, does in fact mean the ſugar-cane. The firſt paſſage in which we have obſerved it mentioned is Exod. xxx. 23. where Moſes is commanded to make an ointment with myrrh, cinnamon, kené, and caſſia. Now the kené does not appear to have been a native of Egypt nor of Judea; for in Jeremiah vi. 20. it is mentioned as coming from a far country. "To what purpoſe cometh there to me incenſe from Sheba and the ſweet-cane from a far country?" This is not true of the calamus aromaticus, which grows ſpontaneouſly in the Levant, as well as in many parts of Europe. If the cinnamon mentioned in the paſſage of Exodus quoted above was true cinnamon, it muſt have come from the Eaſt Indies, the only country in the world from which cinnamon is obtained. There is no difficulty therefore in ſuppoſing, that the ſugar-cane was exported from the ſame country. If any credit be due to etymology, it confirms the opinion that kené denotes the ſugar-cane; for the Latin word *canna* and the Engliſh word *cane* are evidently derived from it. It is alſo a curious fact, that *ſachar* or *ſhcker* *, in Hebrew, ſignifies *inebriation*, from which the Greek word σακχαρ, "ſugar," is undoubtedly to be traced.

3 Account of it by Greek and Roman authors.

* שכר.

The ſugar-cane was firſt made known to the weſtern parts of the world by the conqueſts of Alexander the Great. Strabo † relates that Nearchus his admiral found it in the Eaſt Indies in the year before Chriſt 325. It is evidently alluded to in a fragment of Theophraſtus, preſerved in Photius. Varro, who lived A. C. 68, deſcribes it in a fragment quoted by Iſidorus ‡ as a fluid preſſed from reeds of a large ſize, which was ſweeter than honey §. Dioſcorides, about the year 35 before Chriſt, ſays "that there is a kind of honey called *ſaccharon*, which is found in India and Arabia Felix. It has the appearance of ſalt, and is brittle when chewed. If diſſolved in water, it is beneficial to the bowels and ſtomach, is uſeful in diſeaſes of the bladder and kidneys, and, when ſprinkled on the eye, removes thoſe ſubſtances that obſcure the ſight." This is the firſt account we have of its medical qualities. Galen often preſcribed it as a medicine. Lucan relates, that an oriental nation in alliance with Pompey uſed the juice of the cane as a common drink.

† Lib. xv.

‡ Lib. xvii. cap. 3.

§ *Matthioli Dios.* cap. lxxv.

Quique bibunt tenera dulces ab arundine ſuccos.
Lib. iii. 237.

Pliny ſays it was produced in Arabia and India, but that the beſt came from the latter country. It is alſo mentioned by Arrian, in his Periplus of the Red ſea, by the name of Σαχαρ (*ſachar*) as an article of commerce from India to the Red ſea. Ælian *, Tertullian †, and Alexander Aphrodiſæus ‡, mention it as a ſpecies of honey procured from canes (A).

* *Nat. Hiſt.*

† *De Judicio Dei.*

‡ Lib ii. Prob. 79.

Sugar.

4 Is a native of the Eaſt Indies.

That the ſugar-cane is an indigenous plant in ſome parts of the Eaſt Indies, we have the ſtrongeſt reaſon to believe; for Thunberg found it in Japan, and has accordingly mentioned it as a native of that country in his *Flora Japonica*, publiſhed in 1784. Oſbeck alſo found it in China in 1751. It may indeed have been tranſplanted from ſome other country; but as it does not appear from hiſtory that the inhabitants of Japan or China ever carried on any commerce with remote nations, it could only be conveyed from ſome neighbouring country. Marco Polo, a noble Venetian, who travelled into the eaſt about the year 1250, found ſugar in abundance in Bengal. Vaſco de Gama, who doubled the Cape of Good Hope in 1497, relates, that a conſiderable trade in ſugar was then carried on in the kingdom of Calicut. On the authority of Dioſcorides and Pliny, too, we ſhould be diſpoſed to admit, that it is a native of Arabia, did we not find, on conſulting Niebuhr's Travels, that that botaniſt has omitted it when enumerating the moſt valuable plants of that country. If it be a ſpontaneous production of Arabia, it muſt ſtill flouriſh in its native ſoil. Mr Bruce found it in Upper Egypt. If we may believe the relation of Giovan Lioni, a conſiderable trade was carried on in ſugar in Nubia in 1500: it abounded alſo at Thebes, on the Nile, and in the northern parts of Africa, about the ſame period.

5 Introduced into Europe probably during the cruſades.

There is reaſon to believe that the ſugar-cane was introduced into Europe during the cruſades; expeditions which however romantic in their plan, and unſucceſsful in their execution, were certainly productive of many advantages to the nations of Europe. Albertus Aquenſis, a monkiſh writer, obſerves, that the Chriſtian ſoldiers in the Holy Land frequently derived refreſhment and ſupport during a ſcarcity of proviſions by ſucking the canes. This plant flouriſhed alſo in the Morea, and in the iſlands of Rhodes and Malta; from which it was tranſported into Sicily. The date of this tranſaction it is not eaſy to aſcertain; but we are ſure that ſugar was cultivated in that iſland previous to the year 1166; for Lafitau the Jeſuit, who wrote a hiſtory of the Portugueſe diſcoveries, mentions a donation made that year to the monaſtery of St Bennet, by William the ſecond, king of Sicily, of a mill for grinding ſugar-canes, with all its rights, members, and appurtenances.

From Sicily, where the ſugar-cane ſtill flouriſhes on the ſides of Mount Hybla, it was conveyed to Spain, Madeira, the Canary and Cape de Verd iſlands, ſoon after they were diſcovered in the 15th century.

D'Orville's Travels.

6 Suppoſed by ſome not a native of America or the Weſt Indies.

An opinion has prevailed, that the ſugar-cane is not a native of the weſtern continent, or its adjacent iſlands the Weſt Indies, but was conveyed thither by the Spaniards or Portugueſe ſoon after the diſcovery of America by Columbus. From the teſtimony of Peter Martyr, in the third book of his firſt decade, compoſed during Columbus's ſecond voyage, which commenced in 1493 and ended in 1495, it appears, that the ſugar-cane was known at that time in Hiſpaniola. It may be ſaid, that it was brought thither by Columbus; but for this aſſertion we have found no direct evidence; and though we had

(A) For a more minute account of the hiſtory of ſugar in the early and middle ages, a paper of the Mancheſter Tranſactions, in Volume IV. by Dr Falconer, may be conſulted.

Sugar. had direct evidence, this would not prove that the ſugar-cane was not an indigenous plant of the Weſt Indies. There are authors of learning who, after inveſtigating this ſubject with attention, do not heſitate to maintain, that it is a native both of the iſlands and of the continent of America.

* Tom. iii. c. xv.

7 This opinion opposed by Labat.

P. Labat has ſupported this opinion with much appearance of truth *; and, in particular, he appeals to the teſtimony of Thomas Gage, an Engliſhman, who viſited New Spain in 1625. Gage enumerates ſugar-canes among the proviſions with which the Charaibes of Guadaloupe ſupplied his ſhip. "Now (ſays Labat) it is a fact that the Spaniards had never cultivated an inch of ground in the ſmaller Antilles. Their ſhips commonly touched at thoſe iſlands indeed for wood and water; and they left ſwine in the view of ſupplying with freſh proviſions ſuch of their countrymen as might call there in future; but it would be abſurd in the higheſt degree to ſuppoſe, that they would plant ſugar-canes, and at the ſame time put hogs aſhore to deſtroy them.

"Neither had the Spaniards any motive for beſtowing this plant on iſlands which they conſidered as of no kind of importance, except for the purpoſe that has been mentioned; and to ſuppoſe that the Charaibes might have cultivated, after their departure, a production of which they knew nothing, betrays a total ignorance of the Indian diſpoſition and character.

8 From teſtimony.

"But (continues Labat) we have ſurer teſtimony, and ſuch as proves, beyond all contradiction, that the ſugar-cane is the natural production of America. For, beſides the evidence of Francis Ximenes, who, in a Treatiſe on American Plants, printed at Mexico, aſſerts, that the ſugar-cane grows without cultivation, and to an extraordinary ſize, on the banks of the river Plate, we are aſſured by Jean de Lery, a Proteſtant miniſter, who was chaplain in 1556 to the Dutch garriſon in the fort of Coligny, on the river Janeiro, that he himſelf found ſugar-canes in great abundance in many places on the banks of that river, and in ſituations never viſited by the Portugueſe. Father Hennepen and other voyagers bear teſtimony in like manner to the growth of the cane near the mouth of the Miſſiſſippi; and Jean de Laet to its ſpontaneous production in the iſland of St Vincent. It is not for the plant itſelf, therefore, but for the ſecret of making ſugar from it, that the Weſt Indies are indebted to the Spaniards and Portugueſe; and theſe to the nations of the eaſt."

Such is the reaſoning of Labat, which the learned Lafitau has pronounced incontrovertible; and it is greatly ſtrengthened by recent diſcoveries, the ſugar-cane having been found in many of the iſlands of the Pacific ocean by our late illuſtrious navigator Captain Cook. Sugar.

9 Deſcription of the ſugar cane.

The ſugar-cane, or ſaccharum officinarum of botaniſts, is a jointed reed, commonly meaſuring (the flag part not included) from three feet and a half to ſeven feet in height, but ſometimes riſing to 12 feet. When ripe it is of a fine ſtraw colour inclining to yellow, producing leaves or blades, the edges of which are finely and ſharply ſerrated, and terminating in an arrow decorated with a panicle. The joints in one ſtalk are from 40 to 60 in number, and the ſtalks riſing from one root are ſometimes very numerous. The young ſhoot aſcends from the earth like the point of an arrow; the ſhaft of which ſoon breaks, and the two firſt leaves, which had been incloſed within a quadruple ſheath of ſeminal leaves, riſe to a conſiderable height (B).

10 Soil moſt favourable to its growth.

As the cane is a rank ſucculent plant, it muſt require a ſtrong deep ſoil to bring it to perfection, perhaps indeed no ſoil can be too rich for this purpoſe. The ſoil which experience has found to be moſt favourable to the cultivation of it in the Weſt Indies is the dark gray loam of St Chriſtopher's, which is ſo light and porous as to be penetrable by the ſlighteſt application of the hoe. The under ſtratum is gravel from 8 to 12 inches deep. Canes planted in particular ſpots in this iſland have been known to yield 8000 pounds of Muſcovado ſugar from a ſingle acre. The average produce of the iſland for a ſeries of years has been 16,000 hogſheads of 16 cwt. which is one-half only of the whole cane-land, or 8500 acres. When annually cut, it gives nearly two hogſheads of 16 cwt. per acre for the whole of the land in ripe canes.

Next to the aſhy loam of St Chriſtopher's is the ſoil which in Jamaica is called *brick-mould;* not as reſembling a brick in colour, but as containing ſuch a due mixture of clay and ſand as is ſuppoſed to render it well adapted for the uſe of the kiln. It is a deep, warm, and mellow, hazel earth, eaſily worked; and though its ſurface ſoon grows dry after rain, the under ſtratum retains a conſiderable degree of moiſture in the drieſt weather; with this advantage too, that even in the wetteſt ſeaſon it ſeldom requires trenching. Plant-canes, by which is meant canes of the firſt growth, have been known in very fine ſeaſons to yield two tons and a half of ſugar per acre. After this may be reckoned the black mould of ſeveral varieties. The beſt is the deep black earth of Barbadoes, Antigua, and ſome other of the windward iſlands; but there is a ſpecies of this mould in Jamaica that is but little, if any thing inferior to it, which abounds with limeſtone and flint on a ſubſtratum of ſoapy marle. Black mould on clay is more common; but

Edward's Hiſtory of the Weſt Indies, vol. ii.

(B) "A field of canes, when ſtanding, in the month of November, when it is in arrow or full bloſſom (ſays Mr Beckford in his deſcriptive Account of the Iſland of Jamaica), is one of the moſt beautiful productions that the pen or pencil can poſſibly deſcribe. It in common riſes from three to eight feet or more in height; a difference of growth that very ſtrongly marks the difference of ſoil or the varieties of culture. It is when ripe of a bright and golden yellow; and where obvious to the ſun, is in many parts very beautifully ſtreaked with red: the top is of a darkiſh green; but the more dry it becomes, from either an exceſs of ripeneſs or a continuance of drought, of a ruſſet yellow, with long and narrow leaves depending; from the centre of which ſhoots up an arrow like a ſilver wand from two to ſix feet in height; and from the ſummit of which grows out a plume of white feathers, which are delicately fringed with a lilac dye; and indeed is, in its appearance, not much unlike the tuft that adorns this particular and elegant tree."

but as the mould is generally ſhallow, and the clay ſtiff and retentive of water, this laſt ſort of land requires great labour, both in ploughing and trenching, to render it profitable. When manured and properly pulverized, it becomes very productive. It is unneceſſary to attempt a minute deſcription of all the other ſoils which are found in theſe iſlands. There is, however, a peculiar ſort of land on the north ſide of Jamaica, chiefly in the pariſh of Trelawney, that cannot be paſſed over unnoticed, not only on account of its ſcarcity but its value; few ſoils producing finer ſugars, or ſuch *as anſwer ſo well in the pan;* an expreſſion ſignifying a greater return of refined ſugar than common. The land alluded to is generally of a red colour; the ſhades of which, however, vary conſiderably from a deep chocolate to a rich ſcarlet; in ſome places it approaches to a bright yellow, but it is everywhere remarkable, when firſt turned up, for a gloſſy or ſhining ſurface, and if wetted ſtains the fingers like paint.

11 Proper ſeaſon for planting it.

As in every climate there is a ſeaſon more favourable for vegetation than others, it is of great importance that plants for ſeed be committed to the ground at the commencement of this ſeaſon. As the cane requires a great deal of moiſture to bring it to maturity, the propereſt ſeaſon for planting it is in the months of September and October, when the autumnal rains commence, that it may be ſufficiently luxuriant to ſhade the ground before the dry weather ſets in. Thus the root is kept moiſt, and the crop is ripe for the mill in the beginning of the enſuing year. Canes planted in the month of November, or later in the ſeaſon, loſe the advantage of the autumnal rains; and it often happens that dry weather in the beginning of the enſuing year retards their vegetation until the vernal or May rains ſet in, when they ſprout both at the roots and the joints; ſo that by the time they are cut the field is loaded with unripe ſuckers inſtead of ſugar-canes. A January plant, however, commonly turns out well; but canes planted very late in the ſpring, though they have the benefit of the May rains, ſeldom anſwer expectation; for they generally come in unſeaſonably, and throw the enſuing crops out of regular rotation. They are therefore frequently cut before they are ripe; or if the autumnal ſeaſon ſets in early, are cut in wet weather, which has probably occaſioned them to ſpring afreſh; in either caſe the effect is the ſame: The juice is unconcocted, and all the ſap being in motion, the root is deprived of its natural nouriſhment, to the great injury of the ratoon. The chief objection to a fall plant is this, that the canes become rank and top-heavy, at a period when violent rains and high winds are expected, and are therefore frequently lodged before they are fit to be cut.

12 Method of planting

The ſugar-cane is propagated by the top-ſhoots, which are cut from the tops of the old canes. The uſual method of planting in the Weſt Indies is this: The quantity of land intended to be planted, being cleared of weeds and other incumbrances, is firſt divided into ſeveral plats of certain dimenſions, commonly from 15 to 20 acres each; the ſpaces between each plat or diviſion are left wide enough for roads, for the conveniency of carting, and are called *intervals*. Each plat is then ſubdivided, by means of a line and wooden pegs, into ſmall ſquares of about three feet and a half. Sometimes indeed the ſquares are a foot larger; but this circumſtance makes but little difference. The negroes are then placed in a row in the firſt line, one to a ſquare, and directed to dig out with their hoes the ſeveral ſquares, commonly to the depth of five or ſix inches. The mould which is dug up being formed into a bank at the lower ſide, the excavation or cane-hole ſeldom exceeds 15 inches in width at the bottom, and two feet and a half at the top. The negroes then fall back to the next line, and proceed as before. Thus the ſeveral ſquares between each line are formed into a trench of much the ſame dimenſions with that which is made by the plough. An able negro will dig from 100 to 120 of theſe holes for his day's work of ten hours; but if the land has been previouſly ploughed and lain fallow, the ſame negro will dig nearly double the number in the ſame time (c).

The cane-holes or trench being now completed, whether by the plough or by the hoe, and the cuttings ſelected for planting, which are commonly the tops of the canes that have been ground for ſugar (each cutting containing five or ſix gems), two of them are ſufficient for a cane hole of the dimenſions deſcribed. Theſe, being placed longitudinally in the bottom of the hole, are covered with mould about two inches deep; the reſt of the bank being intended for future uſe. In 12 or 14 days the young ſprouts begin to appear; and as ſoon as they riſe a few inches above the ground, they are, or ought to be, carefully cleared of weeds, and furniſhed with an addition of mould from the banks. This is uſually performed by the hand. At the end of four or five months the banks are wholly levelled, and the ſpaces between the rows carefully hoe-ploughed. Frequent cleanings, while the canes are young, are indeed ſo eſſentially neceſſary, that no other merit in an overſeer can compenſate for the want of attention in this particular. A careful manager will remove at the ſame time all the lateral ſhoots or ſuckers that ſpring up after the canes begin to joint, as they ſeldom come to maturity, and draw nouriſhment from the original plants. 13 and cleaning it.

14 The plough might be uſed with advantage.

" In the cultivation of other lands, in Jamaica eſpecially (ſays Mr Edwards, the elegant hiſtorian of the Weſt Indies, whoſe ſuperior excellence has induced us frequently to refer to him in the courſe of this article), the plough has been introduced of late years, and in ſome few caſes to great advantage; but it is not every ſoil or ſituation that will admit the uſe of the plough; ſome lands being much too ſtony, and others too ſteep; and I am ſorry I have occaſion to remark, that a practice

(c) As the negroes work at this buſineſs very unequally, according to their different degrees of bodily ſtrength, it is ſometimes the practice to put two negroes to a ſingle ſquare; but if the land has not had the previous aſſiſtance of the plough, it commonly requires the labour of 50 able negroes for 13 days to hole 20 acres. In Jamaica, ſome gentlemen, to eaſe their own ſlaves, have this laborious part of the planting-buſineſs performed by job-work. The uſual price for holing and planting is 6l. currency per acre (equal to 4l. 7s. ſterling). The coſt of falling and clearing heavy wood-land is commonly as much more.

Sugar. tice commonly prevails in Jamaica, on properties where this auxiliary is used, which would exhaust the finest lands in the world. It is that of ploughing, then cross-ploughing, round-ridging, and harrowing the same lands from year to year, or at least every other year, without affording manure: accordingly it is found that this method is utterly destructive of the ratoon or second growth, and altogether ruinous. It is indeed astonishing that any planter of common reading or observation should be passive under so pernicious a system. Some gentlemen, however, of late manage better: their practice is to break up stiff and clayey land, by one or two ploughings, early in the spring, and give it a summer's fallow. In the autumn following, being then mellow and more easily worked, it is holed and planted by manual labour after the old method, which has been already described. But in truth, the only advantageous system of ploughing in the West Indies is to confine it to the simple operation of holing, which may certainly be performed with much greater facility and dispatch by the plough than by the hoe; and the relief which, in the case of stiff and dry soils, is thus given to the negroes, exceeds all estimation, in the mind of a humane and provident owner. On this subject I speak from practical knowledge. At a plantation of my own, the greatest part of the land which is annually planted is neatly and sufficiently laid into cane-holes, by the labour of one able man, three boys, and eight oxen, with the common single-wheeled plough. The ploughshare indeed is somewhat wider than usual; but this is the only difference, and the method of ploughing is the simplest possible. By returning the plough back along the furrow, the turf is alternately thrown to the right and to the left, forming a trench seven inches deep, about two feet and a half wide at the top, and one foot wide at the bottom. A space of 18 or 20 inches is left between each trench, on which the mould being thrown by the share, the banks are properly formed, and the holing is complete. Thus the land is not exhausted by being too much exposed to the sun; and in this manner a field of 20 acres is holed with one plough, and with great ease, in 13 days. The plants are afterwards placed in the trench as in the common method, where manual labour alone is employed.

Edwards's History of the West Indies, vol. ii.

In most parts of the West Indies it is usual to hole and plant a certain proportion of the cane-land, commonly one-third, in annual rotation. Canes of the first year's growth are called *plant canes*, as has been already observed. The spouts that spring from the roots of the canes that have been previously cut for sugar are called *ratoons*; the first yearly returns from their roots are called *first ratoons*; the second year's growth *second ratoons*.

13 Canes named according to the age of their roots.

16 Manures employed.

Mr Edwards informs us, that the manure generally used is a compost formed, 1st, Of the vegetable ashes drawn from the fires of the boiling and still houses. 2dly, Feculencies discharged from the still house, mixed up with rubbish of buildings, white-lime, &c. 3dly, Refuse, or field-trash (*i. e.*), the decayed leaves and stems of the canes; so called in contradistinction to cane-trash, reserved for fuel. 4thly, Dung, obtained from the horse and mule stables, and from moveable pens, or small inclosures made by posts and rails, occasionally shifted upon the lands intended to be planted, and into which the cattle are turned at night. 5thly, Good mould, collected from gullies and other waste places, and thrown into the cattle-pens.

17 The sugar-cane destroyed by monkeys,

The sugar-cane is liable to be destroyed by monkeys, rats, and insects. The upland plantations suffer greatly from monkeys; these creatures, which now abound in the mountainous parts of St Christopher's, were first brought thither by the French, when they possessed half that island; they come down from the rocks in silent parties by night, and having posted centinels to give the alarm if any thing approaches, they destroy incredible quantities of the cane, by their gambols as well as their greediness. It is in vain to set traps for these creatures, however baited; and the only way to protect the plantation, and destroy them, is to set a numerous watch, well armed with fowling-pieces, and furnished with dogs. The negroes will perform this service cheerfully, for they are very fond of monkeys as food. The celebrated Father Labat says, they are very delicious, but the white inhabitants of St Kitt's never eat them.

Grainger's History of the sugar-cane.

18 rats,

The low-land plantations suffer as much by rats as those on the mountains do from monkeys; but the rats, no more than the monkeys, are natives of the place; they came with the shipping from Europe, and breed in the ground under loose rocks and bushes: the field negroes eat them greedily, and they are said to be publicly sold in the markets at Jamaica. To free the plantations from these vermin, the breed of wild cats should be encouraged, and snakes suffered to multiply unmolested; they may also be poisoned with arsenic, and the rasped root of the cassava made into pellets, and plentifully scattered over the grounds. This practice, however, is dangerous; for as the rats when thus poisoned become exceeding thirsty, they run in droves to the neighbouring streams, which they poison as they drink, and the cattle grazing on the banks of these polluted waters have frequently perished by drinking after them: It is safer therefore to make the pellets of flour, kneaded with the juice of the nightshade, the scent of which will drive them away though they will not eat it. There is an East Indian animal called *mungoes*, which bears a natural antipathy to rats; if this animal was introduced into our sugar islands, it would probably extirpate the whole race of these noxious vermin. The *formica omnivora* of Linnæus, the carnivorous ant, which is called in Jamaica the *raffle's ant*, would soon clear a sugar plantation of rats.

19 and insects.

The sugar-cane is also subject to a disease which no foresight can obviate, and for which human wisdom has hitherto in vain attempted to find a remedy. This disease is called the *blast*, and is occasioned by a species of *aphis*. When this happens, the fine, broad, green blades become sickly, dry, and withered; soon after they appear stained in spots; and if these spots are carefully examined, they will be found to contain innumerable eggs of an insect like a bug, which are soon quickened, and cover the plants with the vermin: the juice of the canes thus affected becomes sour, and no future shoot issues from the joints. Ants also concur with the bugs to spoil the plantation, and against these evils it is hard to find a remedy.

20 Time at which the crop ripens

The crops of sugar-canes do not ripen precisely at the same period in all the colonies. In the Danish, Spanish, and Dutch settlements, they begin in January, and continue till October. This method does not imply any fixed season for the maturity of the sugar-cane. The plant, Raynal's Hiſtory of the Eaſt and Weſt Indies, vol. iv.

plant, however, like others, muſt have its progreſs; and it hath been juſtly obſerved to be in flower in the months of November and December. It muſt neceſſarily follow, from the cuſtom theſe nations have adopted of continuing to gather their crops for 10 months without intermiſſion, that they cut ſome canes which are not ripe enough, and others that are too ripe, and then the fruit hath not the requiſite qualities. The time of gathering them ſhould be at a fixed ſeaſon, and probably the months of March and April are the fitteſt for it; becauſe all the ſweet fruits are ripe at that time, while the ſour ones do not arrive at a ſtate of maturity till the months of July and Auguſt.

The Engliſh cut their canes in March and April; but they are not induced to do this on account of their ripeneſs. The drought that prevails in their iſlands renders the rains which fall in September neceſſary to their planting; and as the canes are 18 months in growing, this period always brings them to the preciſe point of maturity (D).

21
Seaſon of feſtivity.
Edwards, vol. iv. p. 226.

"The time of crop in the ſugar iſlands (ſays Mr Edwards) is the ſeaſon of gladneſs and feſtivity to man and beaſt. So palatable, ſalutary, and nouriſhing, is the juice of the cane, that every individual of the animal creation, drinking freely of it, derives health and vigour from its uſe. The meagre and ſickly among the negroes exhibit a ſurpriſing alteration in a few weeks after the mill is ſet in action. The labouring horſes, oxen, and mules, though almoſt conſtantly at work during this ſeaſon, yet, being indulged with plenty of the green tops of this noble plant, and ſome of the ſcummings from the boiling-houſe, improve more than at any other period of the year. Even the pigs and poultry fatten on the refuſe. In ſhort, on a well-regulated plantation, under a humane and benevolent director, there is ſuch an appearance during crop-time of plenty and buſy cheerfulneſs, as to ſoften, in a great meaſure, the hardſhips of ſlavery, and induce a ſpectator to hope, when the miſeries of life are repreſented as inſupportable, that they are ſometimes exaggerated through the medium of fancy."

22
The canes when cut are ſent to the mill.

The plants being cut, the branches at the top are given to the cattle for food; the top-ſhoot, which is full of eyes, is preſerved for planting. The canes are cut into pieces about a yard long, tied up in bundles, and carried in carts to the mill, where they are bruiſed, and the juice is extracted from them. The mill conſiſts principally of three upright iron-plated rollers or cylinders, from 30 to 40 inches in length, and from 20 to 25 inches in diameter; and the middle one, to which the moving power is applied, turns the other two by means of cogs. Between theſe rollers, the canes (being previouſly cut ſhort, and tied into bundles) are twice compreſſed; for having paſſed through the firſt and ſecond rollers, they are turned round the middle one by a circular piece of frame-work or ſcreen, called in Jamaica the *Dumb-returner*, and forced back through the ſecond and third; an operation which ſqueezes them completely dry, and ſometimes even reduces them to powder. The cane juice is received in a leaden bed, and thence conveyed into a veſſel called the *receiver*. The refuſe, or macerated rind of the cane (which is called *cane-traſh*, in contradiſtinction to *field-traſh*), ſerves for fuel to boil the liquor.

23
The juice extracted from them.

The juice as it flows from the mill, taken at a medium, contains eight parts of pure water, one part of ſugar, and one part conſiſting of coarſe oil and mucilaginous gum, with a portion of eſſential oil.

24
Veſſels uſed for purifying it are,

As this juice has a ſtrong diſpoſition to fermentation, it muſt be boiled as ſoon as poſſible. There are ſome water-mills that will grind with great eaſe canes ſufficient for 30 hogſheads of ſugar in a week. It is neceſſary to have boiling veſſels, or clarifiers, that will correſpond in dimenſions to the quantity of juice flowing from the receiver. Theſe clarifiers are commonly three in number, and are ſometimes capable of containing 1000 gallons each; but it is more uſual to ſee them of 300 or 400 gallons each. Beſides the clarifiers which are uſed for the firſt boiling, there are generally four coppers or boilers. The clarifiers are placed in the middle or at one end of the boiling-houſe. If at one end, the boiler called the *teache* is placed at the other, and ſeveral boilers (generally three) are ranged between them. The teache is ordinarily from 70 to 100 gallons, and the boilers between the clarifiers and teache diminiſh in ſize from the firſt to the laſt. Where the clarifiers are in the middle, there is uſually a ſet of three boilers of each ſide, which conſtitute in effect a double boiling-houſe. On very large eſtates this arrangement is found uſeful and neceſſary. The objection to ſo great a number is the expence of fuel; to obviate which, in ſome degree, the three boilers on each ſide of the clarifiers are commonly hung to one fire.

25
The clarifier,

The juice runs from the receiver along a wooden gutter lined with lead into the boiling-houſe, where it is received into one of the clarifiers. When the clarifier is filled, a fire is lighted, and a quantity of Briſtol quicklime in powder, which is called *temper*, is poured into the veſſel. The uſe of the lime is to unite with the ſuperabundant acid, which, for the ſucceſs of the proceſs, it is neceſſary to get rid of. The quantity ſufficient to ſeparate the acid muſt vary according to the ſtrength of the quicklime and the quality of the liquor. Some planters allow a pint of lime to every 100 gallons of liquor; but Mr Edwards thinks that little more than half the quantity is a better medium proportion, and even then, that it ought to be diſſolved in boiling water, that as little of it as poſſible may be precipitated. The heat is ſuffered gradually to increaſe till it approaches within a few degrees of the heat of boiling water, that the impurities

(D) The account given in the text concerning the time when the ſugar-canes are collected, we have taken from the Abbé Raynal's Hiſtory of the Trade and Settlements of the Eaſt and Weſt Indies; but Mr Cazaud obſerves, that in February, March, and April, all the canes, whatever be their age, are as ripe as the nature of the ſoil ever allows them to be. He ſays farther, that the dryneſs of the weather, and not the age of the canes, which increaſes from January to April, is the cauſe that in January 400 gallons of juice commonly yield 48 gallons of ſugar and molaſſes, one with another; in February from 56 to 64; in March from 64 to 72; in April ſometimes 80; after which period the ſugar ferments, and even burns, when the refiner is not very expert at his buſineſs.

Philoſoph. Tranſact. vol. lxix.

Sugar.

purities may be thoroughly feparated. But if the liquor were fuffered to boil with violence, the impurities would again incorporate with it. It is known to be fufficiently heated when the fcum begins to rife in blifters, which break into white froth, and appear generally in about 40 minutes. The fire is then fuddenly extinguifhed by means of a damper, which excludes the external air, and the liquor is allowed to remain about an hour undifturbed, during which period the impurities are collected in fcum on the furface. The juice is then drained off either by a fyphon or a cock; the fcum being of a tenacious gummy nature, does not flow out with the liquor, but remains behind in the clarifier. The liquid juice is conveyed from the clarifier by a gutter into the evaporating boiler, commonly termed the *grand copper;* and if it has been obtained from good canes it generally appears tranfparent.

26
and four coppers.

In the evaporating boiler, which fhould be large enough to receive the contents of the clarifier, the liquor is allowed to boil; and as the fcum rifes it is taken off. The fcumming and evaporation are continued till the liquor becomes finer and thicker, and fo far diminifhed in bulk that it may be eafily contained in the fecond copper. When put into the fecond copper, it is nearly of the colour of Madeira wine; the boiling and fcumming are continued, and if the impurities be confiderable, a quantity of lime-water is added. This procefs is carried on till the liquor be fufficiently diminifhed in quantity to be contained in the third copper. After being purified a third time, it is put into the fourth copper, which is called the *teache*, where it is boiled and evaporated till it is judged fufficiently pure to be removed from the fire. In judging of the purity of the liquor, many of the negroes (fays Mr Edwards) guefs folely by the eye (which by long habit they do with great accuracy), judging by the appearance of the grain on the back of the ladle: but the practice moft in ufe is to judge by what is called the *touch;* i. e. taking up with the thumb a fmall portion of the hot liquor from the ladle; and, as the heat diminifhes, drawing with the fore-finger the liquid into a thread. This thread will fuddenly break, and fhrink from the thumb to the fufpended finger, in different lengths, according as the liquor is more or lefs boiled. The proper boiling height for ftrong mufcovado fugar is generally determined by a thread of a quarter of an inch long. It is evident, that certainty in this experiment can be attained only by long habit, and that no verbal precepts will furnifh any degree of fkill in a matter depending wholly on conftant practice.

27
After being clarified it is cooled, granu'ated, and freed from its melaffes.

The juice being thus purified by paffing through the clarifier and four coppers, it is poured into coolers, which are ufually fix in number. The removal from the teache to the cooler is called *ftriking*. The cooler is a fhallow wooden veffel feven feet long, from five to fix wide, about 11 inches deep, and capable of containing a hogfhead of fugar. As the liquor cools, the fugar grains, that is, collects into an irregular mafs of imperfect cryftals, feparating itfelf from the melaffes. It is then removed from the cooler, and conveyed to the curing-houfe, where the melaffes drain from it. For receiving them there is a large ciftern, the floping fides of which are lined with boards. Directly above the ciftern a frame of joift-work without boarding is placed, on which empty hogfheads without heads are ranged. The bottoms of thefe hogfheads are pierced with 8 or 10 holes, in each of which the ftalk of a plantain leaf is fixed fo as to project fix or eight inches below the joints, and rife a little above the top of the hogfhead. The hogfheads being filled with the contents of the cooler, confifting of fugar and melaffes, the melaffes being liquid, drain through the fpungy ftalk, and drop into the ciftern. After the melaffes are drained off, the fugar becomes pretty dry and fair, and is then called *mufcovado* or *raw fugar*.

We have defcribed the procefs for extracting fugar, which is generally adopted in the Britifh Weft India iflands, according to the lateft improvements; and have been anxious to prefent it to our readers in the fimpleft and moft perfpicuous form, that it might be intelligible to every perfon; and have therefore avoided to mention the obfervations and propofed amendments of thofe who have written on this fubject. Had we done fo, we fhould have fwelled the prefent article to too great a fize, without accomplifhing the purpofe which we hav in view; for our intention is not to inftruct the planters, but to give a diftinct account of the moft approved methods which the planters have generally adopted. But though we judge it ufelefs to trouble our readers with all the little varieties in the procefs which different perfons employ, we flatter ourfelves it will not be difagreeable to learn by what methods the French make their fugar purer and whiter than ours. A quantity of fugar from the cooler is put into conical pans or earthen pots, called by the French *formes*, having a fmall perforation at the apex, which is kept clofed. Each cone, reverfed on its apex, is fupported in another earthen veffel. The fyrup is ftirred together, and then left to cryftallize. At the end of 15 or 16 hours, the hole in the point of each cone is opened, that the impure fyrup may run out. The bafe of thefe fugar loaves is then taken out, and white pulverized fugar fubftituted in its ftead; which being well preffed down, the whole is covered with clay moiftened with water. This water filters through the mafs, carrying the fyrup with it which was mixed with the fugar, but which by this management flows into a pot fubftituted in the place of the firft. This fecond fluid is called *fine fyrup*. Care is taken to moiften and keep the clay to a proper degree of foftnefs as it becomes dry. The fugar loaves are afterwards taken out, and dried in a ftove for eight or ten days; after which they are pulverized, packed, and exported to Europe, where they are ftill farther purified. The reafon affigned why this procefs is not univerfally adopted in the Britifh fugar iflands is this, that the water which dilutes and carries away the melaffes diffolves and carries with it fo much of the fugar, that the difference in quality does not pay for the difference in quantity. The French planters probably think otherwife, upwards of 400 of the plantations of St Domingo having the neceffary apparatus for claying and actually carrying on the fyftem.

28
Method of purifying ufed by the French.

Chaptal's Chemiftry, vol. iii.

29
The art of refining fugar introduced by a Venetian.

The art of refining fugar was firft made known to the Europeans by a Venetian, who is faid to have received 100,000 crowns for the invention. This difcovery was made before the new world was explored; but whether it was an invention of the perfon who firft communicated it, or whether it was conveyed from China, where it had been known for a confiderable time before, cannot now perhaps be accurately afcertained. We find no

Anderfon's Origin of Commerce.

mention made of the refining of fugar in Britain till the year 1659, though it probably was practifed feveral years before. For in the Portuguefe ifland of St Thomas in 1624 there were 74 fugar ingenios, each having upwards of 200 flaves. The quantity of raw fugar imported into England in 1778 amounted to 1,403,995 cwts.; the quantity imported into Scotland in the fame year was 117,285 cwts.; the whole quantity imported into Great Britain in 1787 was 1,926,741 cwts.

30 In refining it is mixed with lime water and bullock's blood, and expofed to heat.

The fugar which undergoes the operation of refining in Europe is either raw fugar, fometimes called *mufcovado* or *caffonado*, which is raw fugar in a purer ftate. The raw fugar generally contains a certain quantity of melaffes as well as earthy and feculent fubftances. The caffonado, by the operation of earthing, is freed from its melaffes. As the intention of refining thefe fugars is to give them a higher degree of whitenefs and folidity, it is neceffary for them to undergo other proceffes. The firft of thefe is called *clarification*. It confifts in diffolving the fugar in a certain proportion of lime-water, adding a proper quantity of bullock's blood, and expofing it to heat in order to remove the impurities which ftill remain. The heat is increafed very gradually till it approach that of boiling water. By the affiftance of the heat, the animal matter which was thrown in coagulates, at the fame time that it attracts all the folid feculent and earthy matter, and raifes it to the furface in the appearance of a thick foam of a brownifh colour. As the feculencies are never entirely removed by a firft procefs, a fecond is neceffary. The folution is therefore cooled to a certain degree by adding fome water; then a frefh quantity of blood, but lefs confiderable than at firft, is poured in. The fire is renewed, and care is taken to increafe the heat gently as before. The animal fubftance feizes on the impurities which remain, collects them on the furface, and they are then fkimmed off. The fame operation is repeated a third and even a fourth time, but no addition is made to the liquor except water. If the different proceffes have been properly conducted, the folution will be freed from every impurity, and appear tranfparent. It is then conveyed by a gutter into an oblong bafket about 16 inches deep, lined with a woollen cloth; and after filtering through this cloth, it is received in a ciftern or copper which is placed below.

31 Then freed from its remaining impurities by evaporation.

The folution being thus clarified, it undergoes a fecond general operation called *evaporation*. Fire is applied to the copper into which the folution was received, and the liquid is boiled till it has acquired the proper degree of confiftency. A judgement is formed of this by taking up a fmall portion of the liquid and drawing it into a thread. When, after this trial, it is found fufficiently vifcous, the fire is extinguifhed, and the liquid is poured into coolers. It is then ftirred violently by an inftrument called an *oar*, from the refemblance it bears to the oar of a boat. This is done in order to diminifh the vifcofity, and promote what is called the *granulation*, that is, the forming of it into grains or imperfect cryftals. When the liquid is properly mixed and cooled, it is then poured into moulds of the form of a fugar loaf. Thefe moulds are ranged in rows. The fmall ends, which are loweft, are placed in pots; and they have each of them apertures ftopped up with linen for filtering the fyrup, which runs from the moulds into the pots. The liquor is then taken out flowly in ladlefuls from the coolers, and poured into the moulds. When the moulds are filled, and the contents ftill in a fluid ftate, it is neceffary to ftir them, that no part may adhere to the moulds, and that the fmall cryftals which are juft formed may be equally diffufed through the whole mafs. When the fugar is completely cryftallized, the linen is taken away from the apertures in the moulds, and the fyrup, or that part which did not cryftallize, defcends into the pots in which the moulds are placed. After this purgation the moulds are removed and fixed in other pots, and a ftratum of fine white clay diluted with water is laid on the upper part of the loaf. The water defcending through the fugar by its own weight, mixes with the fyrup which ftill remains in the body of the loaf, and wafhes it away. When the clay dries, it is taken off, and another covering of moift clay put in its place; and if it be not then fufficiently wafhed, a third covering of clay is applied. After the loaves have ftood fome days in the moulds, and have acquired a confiderable degree of firmnefs and folidity, they are taken out, and carried to a ftove, where they are gradually heated to the 50° of Reaumur (64° of Fahrenheit), in order to diffipate any moifture which may be ftill confined in them. After remaining in the ftove eight days, they are taken out; and after cutting off all difcolouring fpecks, and the head if ftill wet, they are wrapped in blue paper, and are ready for fale. The feveral fyrups collected during the different parts of the procefs, treated in the fame manner which we have juft defcribed, afford fugars of inferior quality; and the laft portion, which no longer affords any fugar, is fold by the name of *melaffes*.

32 Afterwards poured into moulds, where the fyrup is drained from it.

33 Laftly expofed to a certain degree of heat.

34 In what the beauty of fugar confifts; how farther refined.

The beauty of refined fugar, when formed into loaves, confifts in whitenefs, joined to a fmallnefs of grain; in being dry, hard, and fomewhat tranfparent. The procefs which we have defcribed above refers to fugar once refined; but fome more labour is neceffary to produce double refined fugar. The principal difference in the operation is this, the latter is clarified by white of eggs inftead of blood, and frefh water in place of lime-water.

35 How fugar-candy is made.

Sugar-candy is the true effence of the cane formed into large cryftals by a flow procefs. When the fyrup is well clarified, it is boiled a little, but not fo much as is done for the proof mentioned in the procefs for making common fugar. It is then placed in old moulds, having their lower ends ftopped with linen, and croffed at little diftances with fmall twigs to retain the fugar as it cryftallizes. The moulds are then laid in a cool place. In proportion as the fyrup cools cryftals are formed. In about nine or ten days the moulds are carried to the ftove, and placed in a pot; but the linen is not removed entirely, fo that the fyrup falls down flowly in drops. When the fyrup has dropped away, and the cryftals of the fugar-candy are become dry, the moulds are taken from the ftove and broken in pieces, to difengage the fugar, which adheres ftrongly to the fides of the moulds. If the fyrup has been coloured with cochineal, the cryftals take a flight taint of red; if indigo has been mixed, they affume a bluifh colour. If it be defired to have the candy perfumed, the effence of flowers or amber may be dropped into the moulds along with the fyrup.

Having now given fome account of the method ufually employed for refining fugar, it will not be improper

Sugar. proper to ſay a few things concerning its nature and its uſes.

36 Chemical qualities of ſugar.

Sugar is ſoluble in water, and in a ſmall degree in alcohol. When united with a ſmall portion of water, it becomes fuſible; from which quality the art of preſerving is indebted for many of its preparations. It is phoſphoric and combuſtible; when expoſed to fire emitting a blue flame if the combuſtion be ſlow, and a white flame if the combuſtion be rapid. By diſtillation it produces a quantity of phlegm, acid, oil, gas, and charcoal. Bergman, in treating ſugar with the nitrous acid, obtained a new acid now known by the name of the *oxalic acid:* but he has omitted to mention the principles of which ſugar is compoſed. Lavoiſier, however, has ſupplied this omiſſion; and after many experiments has aſſigned three principles in ſugar, hydrogen, oxygen, and carbone. If the juice expreſſed from the ſugar-cane be left to itſelf, it paſſes into the acetous fermentation; and during the decompoſition of the ſugar, which is continued for three or four months, a great quantity of glutinous matter is ſeparated. This matter when diſtilled gives a portion of ammoniac. If the juice be expoſed to the ſpirituous fermentation, a wine is obtained analogous to cyder. If this wine, after being kept in bottles a-year, be diſtilled, we obtain a portion of *eau de vie.*

37 Its uſes in medicine, &c.

The uſes to which ſugar are applied are indeed numerous and important: It can be made ſo ſolid as in the art of preſerving to receive the moſt agreeable colours and the greateſt variety of forms. It can be made ſo fluid as to mix with any ſoluble ſubſtance.—It preſerves the juice and ſubſtance of fruits in all countries and in all ſeaſons. It affords a delicious ſeaſoning to many kinds of food. It is uſeful in pharmacy, for it unites with medicines, and removes their diſagreeable flavour: it is the baſis of all ſyrups. M. Macquer has ſhown in a very ſatisfactory manner how uſeful ſugar would be if employed in fermenting wines. Sugar has alſo been found a remedy for the ſcurvy, and a valuable article of food in caſes of neceſſity. M. Imbert de Lennes, firſt ſurgeon to the late duke of Orleans, publiſhed the following ſtory in the *Gazette de Santé*, which confirms this aſſertion. A veſſel laden with ſugar bound from the Weſt Indies was becalmed in its paſſage for ſeveral days, during which the ſtock of proviſions was exhauſted. Some of the crew were dying of the ſcurvy, and the reſt were threatened with a ſtill more terrible death. In this emergency recourſe was had to the ſugar. The conſequence was, the ſymptoms of the ſcurvy went off, the crew found it a wholeſome and ſubſtantial aliment, and returned in good health to France.

38 Affords the greateſt quantity of nouriſhment of any kind of food.

"Sugar (ſays Dr Ruſh) affords the greateſt quantity of nouriſhment in a given quantity of matter of any ſubſtance in nature; of courſe it may be preſerved in leſs room in our houſes, and may be conſumed in leſs time, than more bulky and leſs nouriſhing aliment. It has this peculiar advantage over moſt kinds of aliment, that it is not liable to have its nutritious qualities affected by time or the weather; hence it is preferred by the Indians in their excurſions from home. They mix a certain quantity of maple ſugar, with an equal quantity of Indian corn, dried and powdered, in its milky ſtate. This mixture is packed in little baſkets, which are frequently wetted in travelling, without injuring the ſugar. A few ſpoonfuls of it mixed with half a pint of ſpring water afford them a pleaſant and ſtrengthening meal. From the degrees of ſtrength and nouriſhment which are conveyed into animal bodies by a ſmall bulk of ſugar, it might probably be given to horſes with great advantage, when they are uſed in places or under circumſtances which make it difficult or expenſive to ſupport them with more bulky or weighty aliment. A pound of ſugar with graſs or hay has ſupported the ſtrength and ſpirits of a horſe during a whole day's labour in one of the Weſt-India iſlands. A larger quantity given alone has fattened horſes and cattle, during the war before laſt in Hiſpaniola, for a period of ſeveral months, in which the exportation of ſugar, and the importation of grain, were prevented by the want of ſhips.

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39 An excellent antidote againſt worms.

"The plentiful uſe of ſugar in diet is one of the beſt preventives that has ever been diſcovered of the diſeaſes which are produced by worms. Nature ſeems to have implanted a love for this aliment in all children, as if it were on purpoſe to defend them from thoſe diſeaſes. Dr Ruſh knew a gentleman in Philadelphia, who early adopted this opinion, and who, by indulging a large family of children in the uſe of ſugar, has preſerved them all from the diſeaſes uſually occaſioned by worms.

40 and probably againſt the plague and other malignant fevers.

"Sir John Pringle has remarked, that the plague has never been known in any country where ſugar compoſes a material part of the diet of the inhabitants. Dr Ruſh thinks it probable that the frequency of malignant fevers of all kinds has been leſſened by this diet, and that its more general uſe would defend that claſs of people who are moſt ſubject to malignant fevers from being ſo often affected by them.

"In the numerous and frequent diſorders of the breaſt, which occur in all countries where the body is expoſed to a variable temperature of weather, ſugar affords the baſis of many agreeable remedies. It is uſeful in weakneſſes, and acrid defluxions upon other parts of the body. Many facts may be adduced in favour of this aſſertion. Dr Ruſh mentions only one, which, from the venerable name of the perſon whoſe caſe furniſhed it, cannot fail of commanding attention and credit. Upon my inquiring of Dr Franklin, at the requeſt of a friend (ſays our reſpectable author), about a year before he died, whether he had found any relief from the pain of the ſtone from the blackberry jam, of which he took large quantities, he told me that he had, but that he believed the medicinal part of the jam reſided wholly in the ſugar; and as a reaſon for thinking ſo, he added, that he often found the ſame relief by taking about half a pint of a ſyrup, prepared by boiling a little brown ſugar in water, juſt before he went to bed, that he did from a doſe of opium. It has been ſuppoſed by ſome of the early phyſicians of our country, that the ſugar obtained from the maple-tree is more medicinal than that obtained from the Weſt India ſugar-cane; but this opinion I believe is without foundation. It is preferable in its qualities to the Weſt India ſugar only from its ſuperior cleanlineſs.

41 Has given relief from the pain of the ſtone.

"Caſes may occur in which ſugar may be required in medicine, or in diet, by perſons who refuſe to be benefited, even indirectly by the labour of ſlaves. In ſuch caſes the innocent maple ſugar will always be preferred. It has been ſaid, that ſugar injures the teeth; but this opinion now has ſo few advocates, that it does not deſerve a ſerious refutation."

42 Not hurtful to the teeth.

In

In the account which we have given above of the method of cultivating and manufacturing ſugar, we have had in our eye the plantations in the Weſt Indies, where ſlaves alone are employed; but we feel a peculiar pleaſure in having it in our power to add a ſhort deſcription of the method uſed in the Eaſt Indies, becauſe there ſugar is manufactured by free men, on a plan which is much more economical than what is followed in the Weſt Indies. The account which we mean to give is an extract from the report of the committee of Privy-council for trade on the ſubject of the African ſlave-trade, drawn up by Mr Botham. We ſhall give it in the author's own words.

43
Sugar manufactured in the Eaſt Indies by free men,

"Having been for two years in the Engliſh and French Weſt India iſlands, and ſince conducted ſugar eſtates in the Eaſt Indies; before the abolition of the ſlave-trade was agitated in parliament, it may be deſirable to know that ſugar of a ſuperior quality and inferior price to that in our iſlands is produced in the Eaſt Indies; that the culture of the cane, the manufacture of the ſugar and arrack, is, with theſe material advantages, carried on by free people. China, Bengal, the coaſt of Malabar, all produce quantities of ſugar and ſpirits; but as the moſt conſiderable growth of the cane is carried on near Batavia, I ſhall explain the improved manner in which ſugar eſtates are there conducted. The proprietor of the eſtate is generally a wealthy Dutchman, who has erected on it ſubſtantial mills, boiling and curing houſes. He rents this eſtate to a Chineſe, who reſides on it as a ſuperintendant; and this renter (ſuppoſing the eſtate to conſiſt of 300 or more acres) relets it to free men in parcels of 50 or 60 on theſe conditions: "That they ſhall plant it in canes, and receive ſo much per pecul of $133\frac{1}{3}$ pounds for every pecul of ſugar that the canes ſhall produce."

44
of a ſuperior quality and at a lower price.

45
How ſugar eſtates are managed at Batavia.

When crop time comes on, the ſuperintendant collects a ſufficient number of perſons from the adjacent towns or villages, and takes off his crop as follows. To any ſet of tradeſmen who bring their carts and buffaloes he agrees to give ſuch a price per pecul to cut all his crop of canes, carry them to the mill and grind them. A ſecond to boil them per pecul. A third to clay them and baſket them for market per pecul. So that by this method of conducting a ſugar eſtate the renter knows to a certainty what the produce of it will coſt him per pecul. He has not any permanent or unneceſſary expence; for when the crop is taken off, the taſkmen return to their ſeveral purſuits in the towns and villages they came from; and there only remain the cane planters who are preparing the next year's crop. This like all other complex arts, by being divided into ſeveral branches, renders the labour cheaper and the work more perfectly done.

Only clayed ſugars are made at Batavia; theſe are in quality equal to the beſt ſort from the Weſt Indies, and are ſold ſo low from the ſugar eſtates as eighteen ſhillings ſterling per pecul of $133\frac{1}{3}$libs. This is not the ſelling price to the trader at Batavia, as the government there is arbitrary, and ſugar ſubject to duties impoſed at will. The Shabander exacts a dollar per pecul on all ſugar exported. The price of common labour is from 9d. to 10d. per day. By the method of carrying on the ſugar eſtates, the taſkmen gain conſiderably more than this not only from working extraordinary hours, but from being conſidered artiſts in their ſeveral branches. They do not make ſpirits on the ſugar eſtates. The melaſſes is ſent for ſale to Batavia, where one diſtillery may purchaſe the produce of an hundred eſtates. Here is a vaſt ſaving and reduction of the price of ſpirits; not as in the Weſt Indies, a diſtillery, for each eſtate; many centre in one, and arrack is ſold at Batavia from 21 to 25 rixdollars per leaguer of 160 gallons; ſay 8d. per gallon."

46
Deſcription of the ſugar maple.

The SUGAR MAPLE, (the *acer ſaccharinum* of Linnæus), as well as the ſugar-cane, produces a great quantity of ſugar. This tree grows in great numbers in the weſtern counties of all the middle ſtates of the American union. Thoſe which grow in New York and Pennſylvania yield the ſugar in a greater quantity than thoſe which grow on the waters of the Ohio.—Theſe trees are generally found mixed with the beech, hemlock, white and water aſh, the cucumber tree, linden, aſpen, butter nut, and wild cherry trees. They ſometimes appear in groves covering five or ſix acres in a body, but they are more commonly interſperſed with ſome or all of the foreſt trees which have been mentioned. From 30 to 50 trees are generally found upon an acre of ground. They grow only in the richeſt ſoils, and frequently in ſtony ground. Springs of the pureſt water abound in their neighbourhood. They are, when fully grown, as tall as the white and black oaks, and from two to three feet in diameter. They put forth a beautiful white bloſſom in the ſpring before they ſhow a ſingle leaf. The colour of the bloſſom diſtinguiſhes them from the acer rubrum, or the common maple, which affords a bloſſom of a red colour. The wood of the ſugar maple-tree is extremely inflammable, and is preferred upon that account by hunters and ſurveyors for fire-wood. Its ſmall branches are ſo much impregnated with ſugar as to afford ſupport to the cattle, horſes, and ſheep of the firſt ſettlers, during the winter, before they are able to cultivate forage for that purpoſe. Its aſhes afford a great quantity of potaſh, exceeded by few, or perhaps by none, of the trees that grow in the woods of the United States. The tree is ſuppoſed to arrive at its full growth in the woods in twenty years.

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47
The oftener this tree is tapped the more ſyrup is obtained from it.

It is not injured by tapping; on the contrary, the oftener it is tapped, the more ſyrup is obtained from it. In this reſpect it follows a law of animal ſecretion. A ſingle tree had not only ſurvived, but flouriſhed after forty-two tappings in the ſame number of years. The effects of a yearly diſcharge of ſap from the tree, in improving and increaſing the ſap, are demonſtrated from the ſuperior excellence of thoſe trees which have been perforated in an hundred places, by a ſmall wood-pecker which feeds upon the ſap. The trees, after having been wounded in this way, diſtil the remains of their juice on the ground, and afterwards acquire a black colour. The ſap of theſe trees is much ſweeter to the taſte than that which is obtained from trees which have not been previouſly wounded, and it affords more ſugar.

48
What quantity of ſap will produce a certain quantity of ſugar.

From twenty-three gallons and one quart of ſap, procured in twenty-four hours from only two of theſe dark coloured trees, Arthur Noble, Eſq. of the ſtate of New York, obtained four pounds and thirteen ounces of good grained ſugar.

A tree of an ordinary ſize yields in a good ſeaſon from twenty to thirty gallons of ſap, from which are made from five to ſix pounds of ſugar. To this there are ſometimes

Sugar. times remarkable exceptions. Samuel Lowe, Esq. a justice of peace in Montgomery county, in the state of New York, informed Arthur Noble, Esq. that he had made twenty pounds and one ounce of sugar between the 14th and 23d of April, in the year 1789, from a single tree that had been tapped for several successive years before.

49 This quantity might be increased by culture. From the influence which culture has upon forest and other trees, it has been supposed, that by transplanting the sugar maple-tree into a garden, or by destroying such other trees as shelter it from the rays of the sun, the quantity of the sap might be increased, and its quality much improved. A farmer in Northampton county, in the state of Pennsylvania, planted a number of these trees above twenty years ago in his meadow, from three gallons of the sap of which he obtains every year a pound of sugar. It was observed formerly, that it required five or six gallons of the sap of the trees which grow in the woods to produce the same quantity of sugar.

50 The sap distils from the wood in the spring months. The sap distils from the wood of the tree. Trees which have been cut down in the winter for the support of the domestic animals of the new settlers, yield a considerable quantity of sap as soon as their trunks and limbs feel the rays of the sun in the spring of the year. It is in consequence of the sap of these trees being equally diffused through every part of them, that they live three years after they are girdled, that is, after a circular incision is made through the bark into the substance of the tree for the purpose of destroying it. It is remarkable that grass thrives better under this tree in a meadow, than in situations exposed to the constant action of the sun. The season for tapping the trees is in February, March, and April, according to the weather which occurs in these months.

51 Is increased by warm days and frosty nights. Warm days and frosty nights are most favourable to a plentiful discharge of sap. The quantity obtained in a day from a tree is from five gallons to a pint, according to the greater or less heat of the air. Mr Lowe informed Arthur Noble, Esq. that he obtained near three and twenty gallons of sap in one day (April 14. 1789.) from the single tree which was before mentioned. Such instances of a profusion of sap in single trees are however not very common.

52 How the sap is drained from the tree. There is always a suspension of the discharge of sap in the night if a frost succeed a warm day. The perforation in the tree is made with an axe or an auger. The latter is preferred from experience of its advantages. The auger is introduced about three quarters of an inch, and in an ascending direction (that the sap may not be frozen in a slow current in the mornings or evenings), and is afterwards deepened gradually to the extent of two inches. A spout is introduced about half an inch into the hole made by this auger, and projects from three to twelve inches from the tree. The spout is generally made of the sumach or elder, which usually grows in the neighbourhood of the sugar trees. The tree is first tapped on the south side; when the discharge of its sap begins to lessen, an opening is made on the north side, from which an increased discharge takes place. The sap flows from four to six weeks, according to the temperature of the weather. Troughs large enough to contain three or four gallons made of white pine, or white ash, or of dried water ash, aspen, linden, poplar, or common maple, are placed under the spout to receive the sap, which is carried every day to a large receiver, made of either of the trees before mentioned. From this receiver it is conveyed, after being strained, to the boiler.

Sugar || Sugillation.

53 Is reduced to sugar by three modes. We understand that there are three modes of reducing the sap to sugar; by evaporation, by freezing, and by boiling; of which the latter is most general, as being the most expeditious. We are farther assured, that the profit of the maple tree is not confined to its sugar. It affords most agreeable melasses, and an excellent vinegar. The sap which is suitable for these purposes is obtained after the sap which affords the sugar has ceased to flow, so that the manufactories of these different products of the maple tree, by succeeding, do not interfere with each other. The melasses may be made to compose the basis of a pleasant summer beer. The sap of the maple is moreover capable of affording a spirit; but we hope this precious juice will never be prostituted to this ignoble purpose. Should the use of sugar in diet become more general in this country (says Dr Rush) it may tend to lessen the inclination or supposed necessity for spirits, for I have observed a relish for sugar in diet to be seldom accompanied by a love for strong drink.

54 Sugar procured from many other vegetables. There are several other vegetables raised in our own country which afford sugar; as beet-roots, skirrets, parsneps, potatoes, celeri, red cabbage stalks, the young shoots of Indian wheat. The sugar is most readily obtained from these, by making a tincture of the subject in rectified spirit of wine; which, when saturated by heat, will deposit the sugar upon standing in the cold.

Sugar of Milk. See Milk, Chemistry *Index*.

Acid of Sugar. See Chemistry *Index*.

SUGILLATION, in *Medicine*, an extravasation of blood in the coats of the eye, which at first appears of a reddish colour, and afterwards livid or black. If the disorder is great, bleeding and purging are proper, as are also discutients.

END OF THE NINETEENTH VOLUME.

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